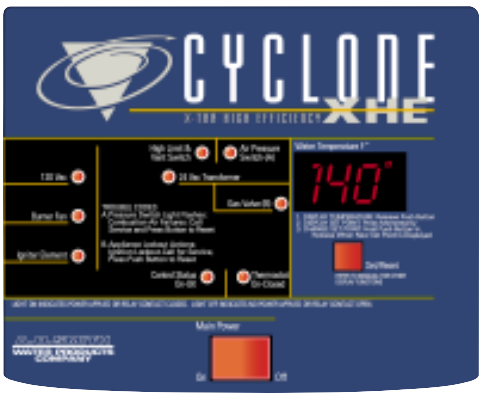
A.O. SMITH

WATER PRODUCTS COMPANY

BTH 120, 150, 199, 250 Service Handbook

Includes Parts List For Series 960 through 967



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BTH HANDBOOK
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BTH HANDBOOK INTRODUCTION

This service handbook is designed to aid in servicing and troubleshooting A. O. Smith BTH water heaters in the field. No duplication or reproduction of this book may be made without the express written authorization of the A. O. Smith Water Products Company.

The following text and illustrations will provide you with a step by step procedure to verify proper installation, operation and troubleshooting procedures. Additional quick reference data is included to assist you in servicing this product.

The information contained in this handbook is designed to answer commonly faced situations encountered in the operation of the BTH product line and is not meant to be all inclusive. If you are experiencing a problem not covered in this handbook, please contact the A. O. Smith Technical Information Department at 1-800-527-1953 or your local A. O. Smith Water Products company representative for further assistance. This handbook is intended for use by licensed plumbing professionals and reference should be made to the instruction manual accompanying the product. This handbook contains supplemental information to the BTH instruction manual.

Qualifications: Installation or service of this water heater requires ability equivalent to that of a licensed tradesman in the field involved. Plumbing, venting, gas supply and electrical testing skills are required.

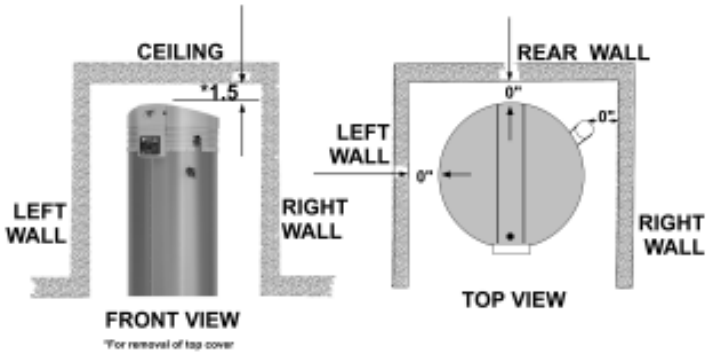
Tools Required:

- Phillips head screw driver
- Flat tip screw drivers
- Set of marked drill bits
- Electric multimeter tester
- Gas pressure gauge or manometer (gauge - AOS part number 8099-2)
- Water pressure gauge (AOS part number 4798)
- Draft gauge
- Thermometer (AOS part number 4870 - range 0 thru 220°F)
- 1/2 inch socket with extension for removal of the cleanout
- 1 1/8 inch socket for removal of the anode
- 1 inch socket for hot surface igniter removal
- Pipe wrench for union disconnect

***Note:** Also, have a copy of the instruction manual for the model and series BTH that you are servicing.

Revision 2 includes an added Multiple Venting statement on page 3 and a new Blower Motor Ohms Resistance Table on page 25. The Pressure Switch Table on page 32 was expanded/revised.

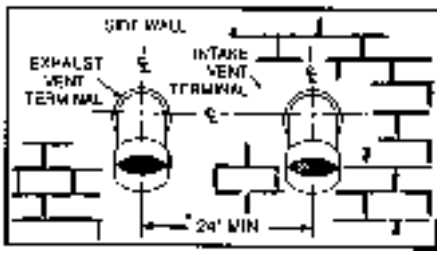
Installation: This portion of the handbook will review often overlooked installation considerations, taking note of necessary instruction requirements for the BTH 120 - 250 / 966 and 967 Series. The installation manual covers most of these items in detail. BTH heaters are approved for installation on combustible flooring. Most can be installed in an alcove with minimum clearances to combustibles or non-combustibles of 0 inches from the sides and rear, 0 inches from vent piping, and 1.5 inches from the top cover. A 24 inch clearance for all serviceable parts is recommended. Clearances may vary between BTH models. See instruction manual or the label on the heater for clearances applicable to your specific model.

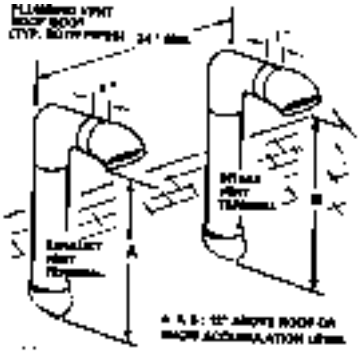


This illustrates the exterior clearances for these BTH units when installed as direct vent heaters.

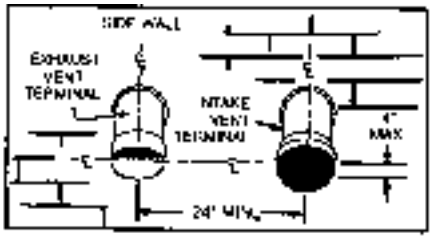
Note: 24 inches between inlet and outlet is a minimum. Greater distance is recommended. In colder climates increasing the 24" minimum to a maximum practical distance, will reduce the possibility of frost over from side winds blowing exhaust vapors to the air intake of the direct vent.

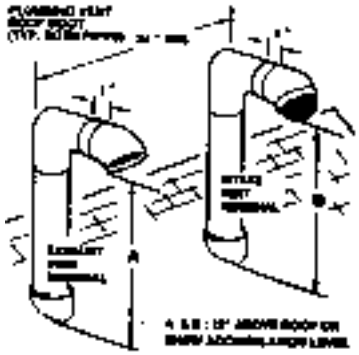
BTH Model 120



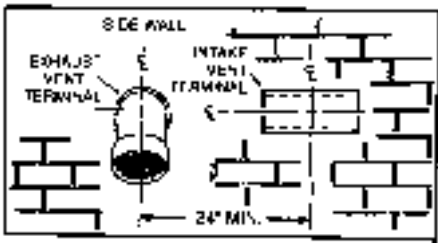


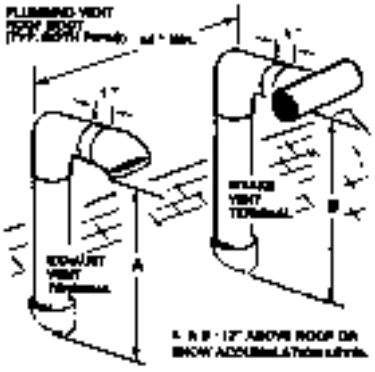
BTH Model 150-199





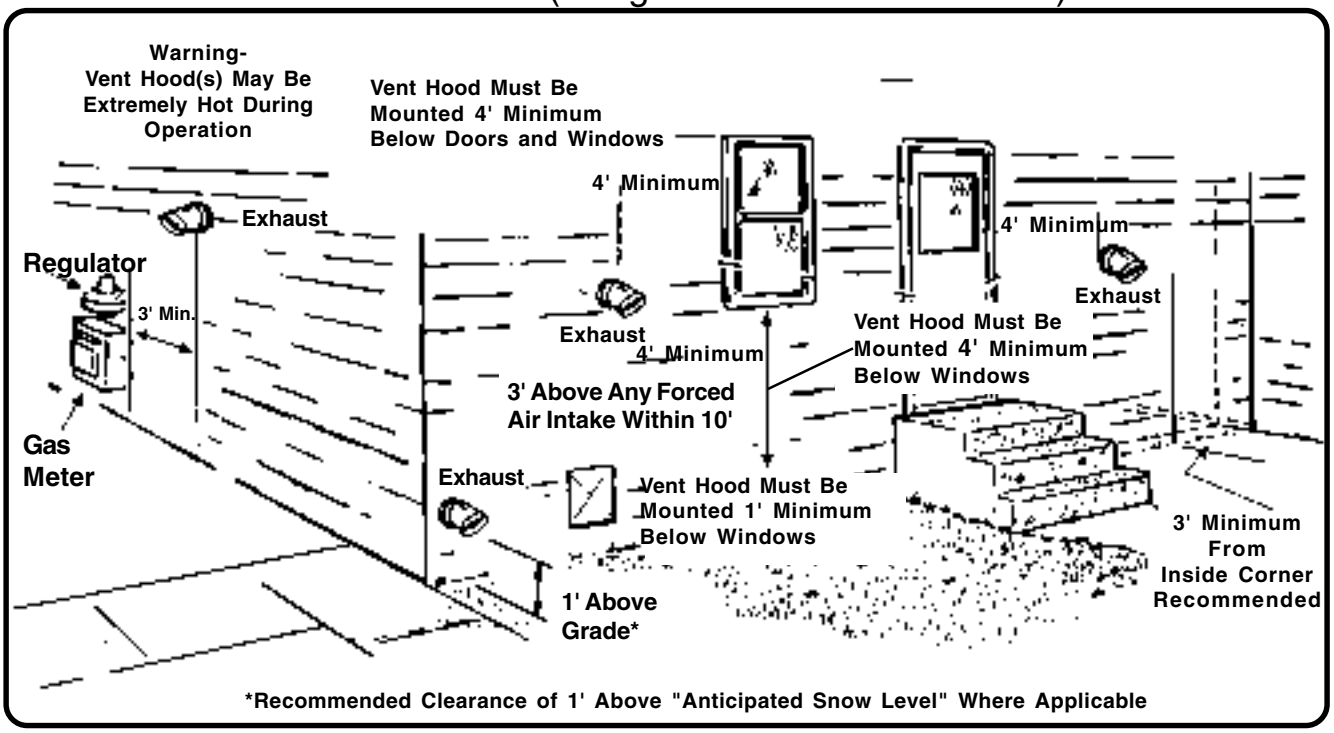
BTH Model 250





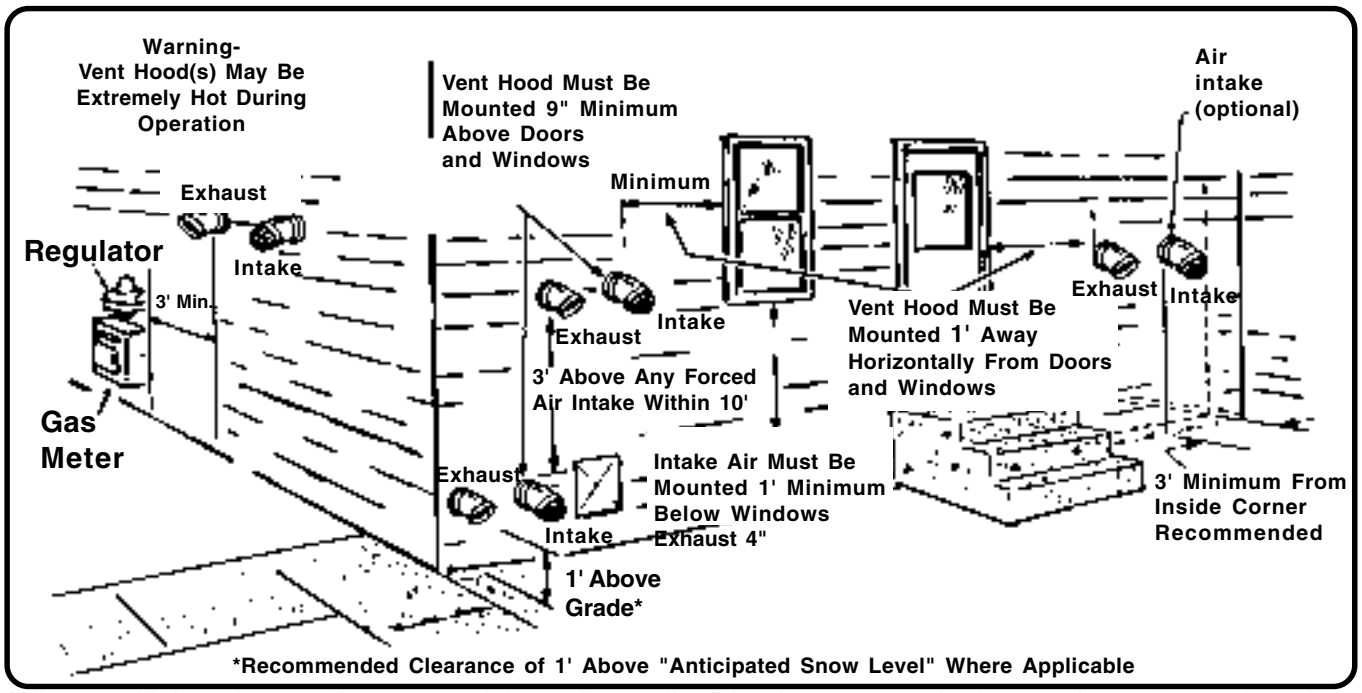
EXTERIOR CLEARANCES

Horizontal Vent (using room air for combustion)



EXTERIOR CLEARANCES

Direct Vent



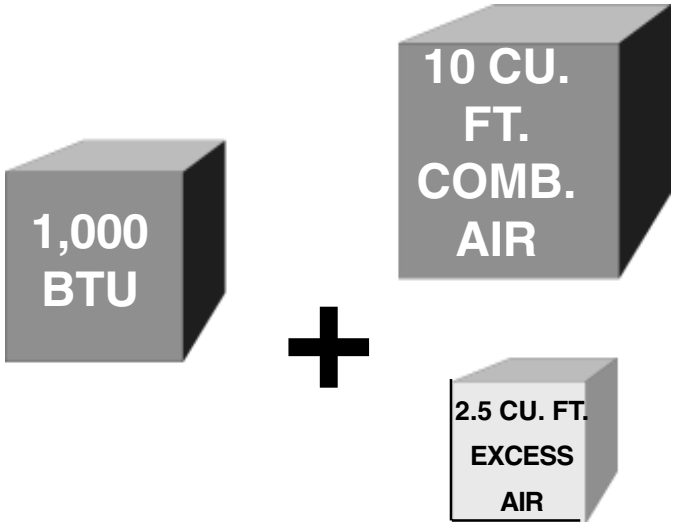
When multiple units are direct vented through a wall, all intake vent terminals must be no lower than the highest exhaust vent terminal.

CAUTION

DO NOT TERMINATE THE VENTING WHERE NOISE FROM THE EXHAUST OF INTAKE WILL BE OBJECTIONABLE. THIS INCLUDES LOCATIONS CLOSE TO OR ACROSS FROM WINDOWS AND DOORS. AVOID ANCHORING THE VENT AND INTAKE PIPES DIRECTLY TO FRAMED WALLS, FLOORS OR CEILINGS UNLESS RUBBER ISOLATION PIPE HANGERS ARE USED. THIS PREVENTS ANY VIBRATIONS FROM BEING TRANSMITTED INTO THE LIVING SPACES.

MINIMUM AIR FOR COMBUSTION

10 CUBIC FEET OF AIR PER 1,000 BTU

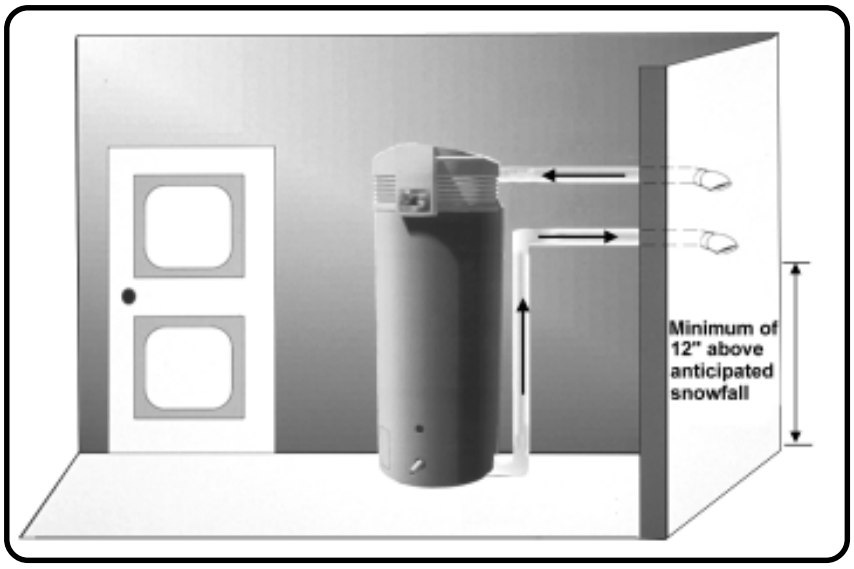


Stoichiometric or theoretical complete combustion requires 10 cubic feet of air per 1000 BTUH input of the gas input. The National Fuel Gas Code also recommends an additional 2.5 cu.ft. of "excess air". This 12.5 cu.ft. minimum supply air per 100 BTUH input applies to natural and propane gas models.

The National Fuel Code also specifies minimum make-up air opening sizes for various building installations. (Ref: NFPA 54, ANSI Z223.1, sec 5.3).

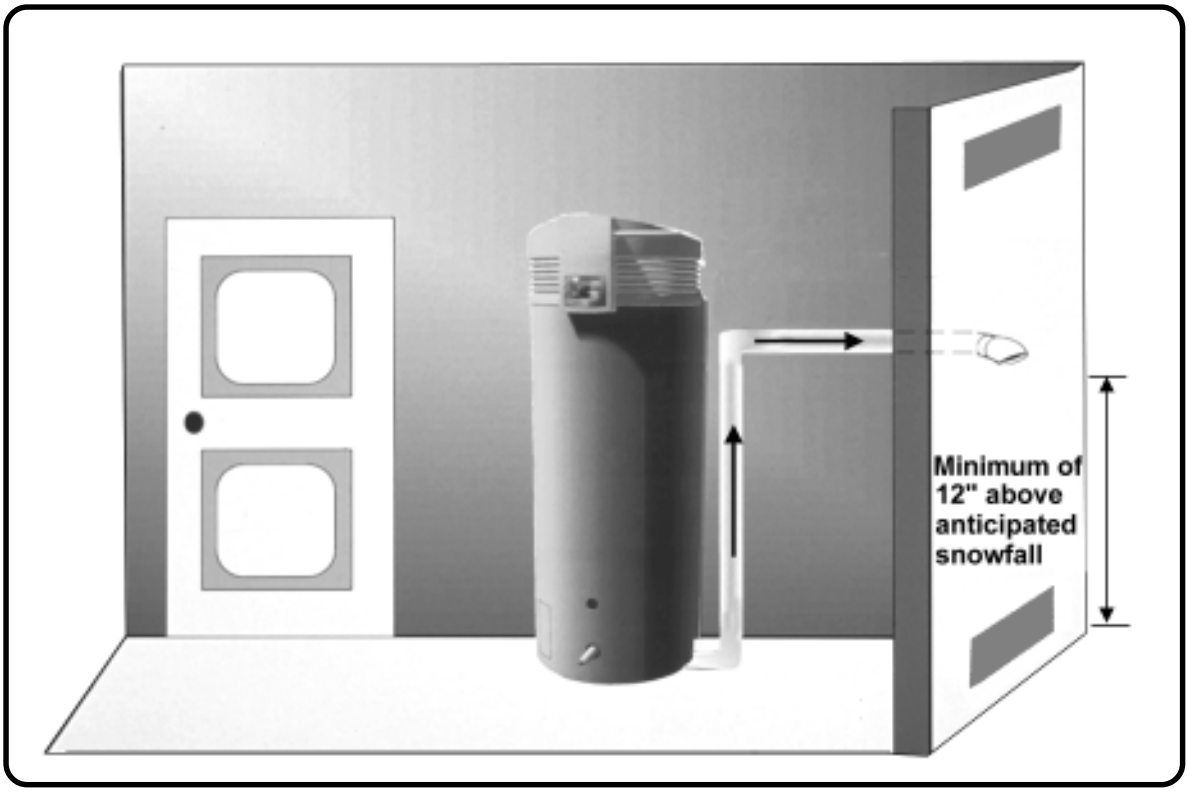
MAKE-UP AIR

DIRECT VENT INSTALLATION



This model is approved for direct venting either horizontally or vertically or conventional venting horizontal or vertical. Direct venting avoids using room air for combustion and eliminates the need for additional air intake ducts. The direct vent installation may have up to 50 equivalent feet of exhaust and 50 equivalent feet of air intake piping

MAKE-UP AIR
DIRECT COMMUNICATION

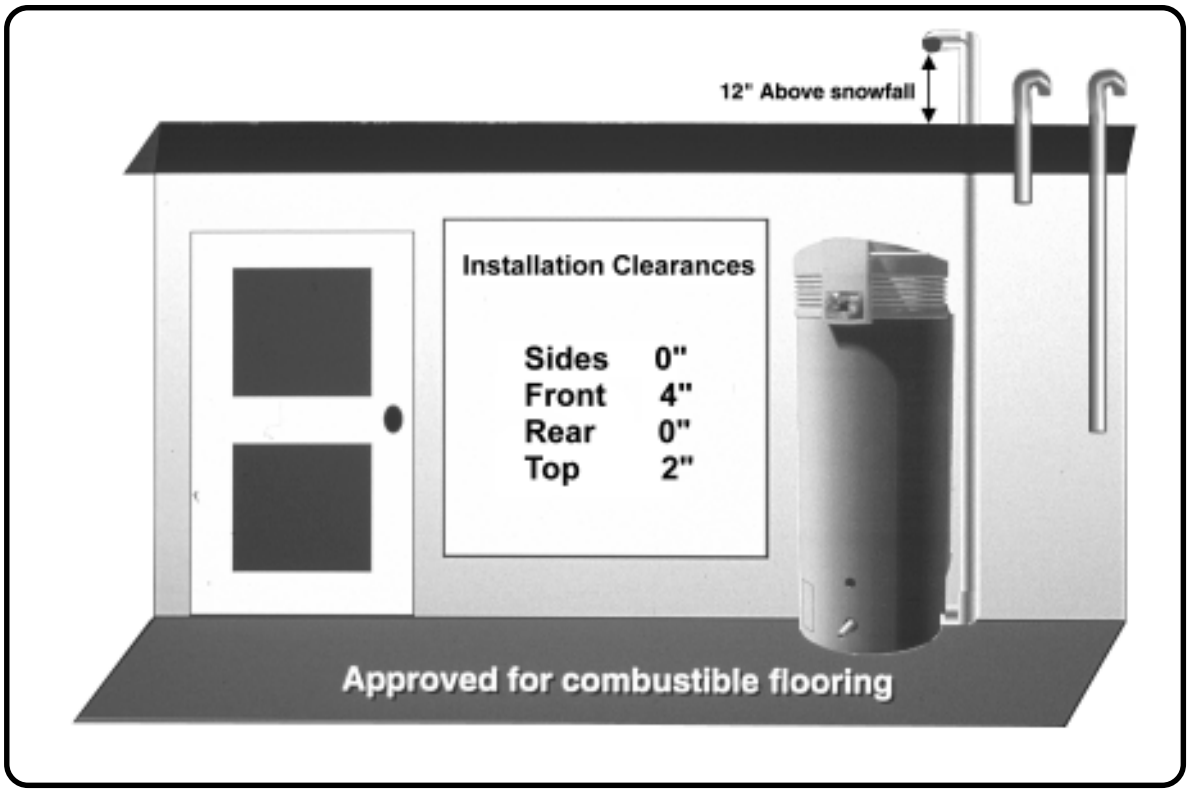


A fresh supply of make-up air for combustion can be supplied to the heater through make-up air ducts, which directly communicate with the out of doors. Two openings are required - one within 12 inches of the top of the enclosure and one within 12 inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

The lower opening is primarily providing combustion air. The upper opening is providing vent dilution air and acts as a relief opening for flue gases should the vent become obstructed or a down draft condition occur. Additionally, when the heater is installed in a confined space and communicating with the outdoor air, one permanent opening, commencing within 12 inches (30 cm.) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 inch (2.5 cm.) from the sides and back and 6 inches (16 cm.) from the front of the appliance. The opening shall directly communicate with the outdoors and shall communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and shall have a minimum free area of:

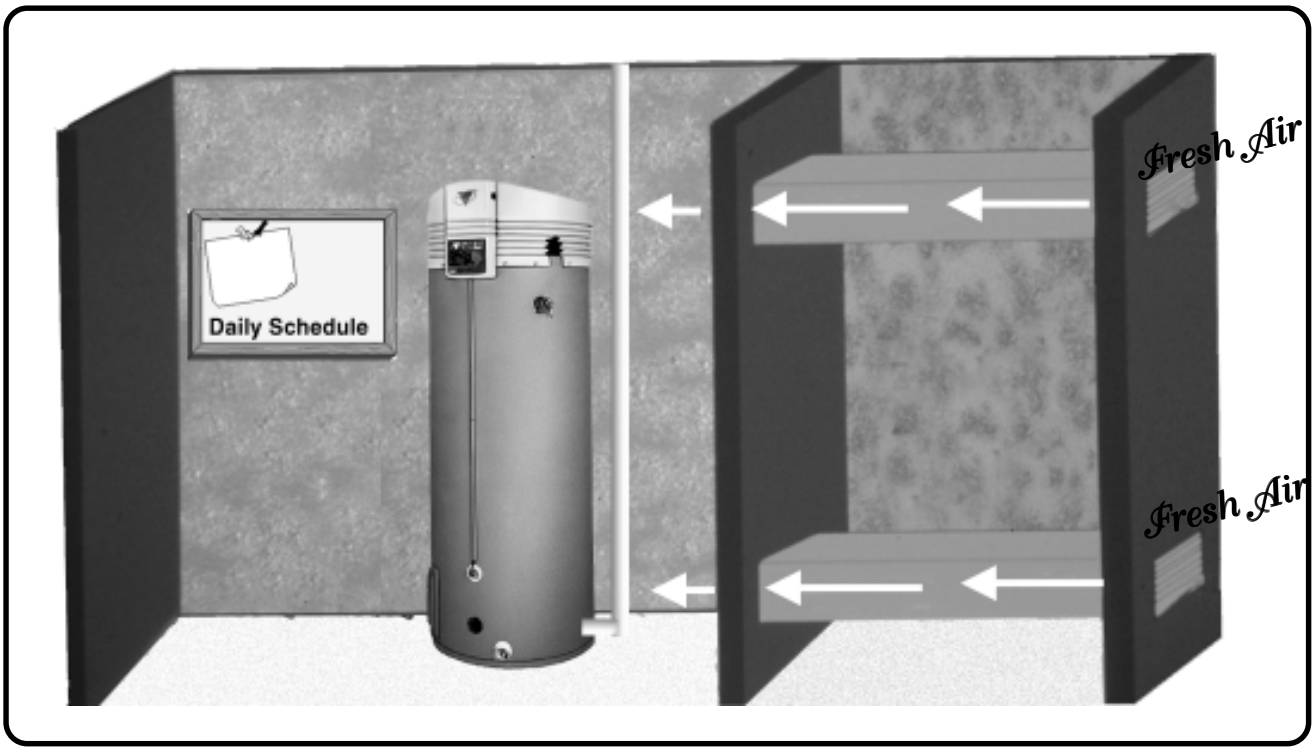
a. 1 sq. in. per 3000 BTU per hr (7 cm2 per kW) of the total input of all equipment located in the enclosure, and
b. Not less then the sum of the areas of all vent connectors in the confined space.

MAKE-UP AIR
VERTICAL DUCTS



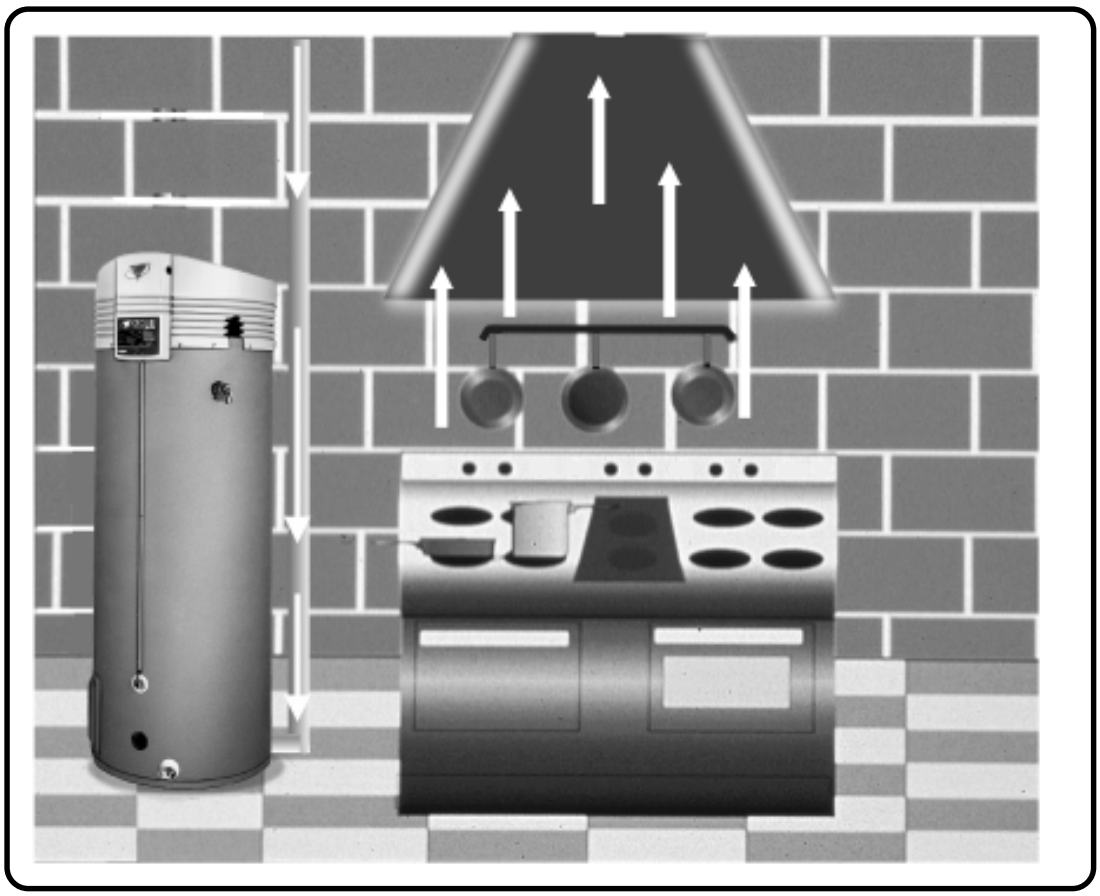
Often it is more practical to install vertical make-up air ducts to the out doors. Again, two openings are required - within 12 inches (30 cm.) of the top of the enclosure and one within 12 inches (30 cm.) of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

MAKE-UP AIR
HORIZONTAL DUCTS



When the heater is installed in an interior room with no roof access for vertical ducts, horizontal make-up ducts should be installed. When using horizontal ducts, two openings are required - within 12 inches (30 cm.) of the top of the enclosure and one within 12 inches (30 cm.) of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 2000 BTUH of the total input of all appliances within the enclosure.

INSUFFICIENT MAKE-UP AIR
BACKDRAFT



Insufficient make-up air is a major cause of combustion problems. One common example is in a restaurant installation where exhaust vent equipment was not considered in sizing make-up air requirements. This may result in air being backdrafted by the restaurant exhaust equipment through the heater causing flue gas spillage, flame roll out, improper combustion, inconsistent pilot operation, and/or erratic heater shutdown.

A possible solution to this situation would be to use a BTH with direct venting.

A less common service issue associated with a backdraft or negative pressure room would be the opening or closing of air pressure switches. This may result in erratic or no heater operation.

CONTAMINATED AIR

Along with adequate make-up air, the quality of the air is important. Contaminants in combustion air can lead to premature heater failure. Vapors from bleaches, soaps, salts, etc. are drawn into the combustion chamber with the make up air and, once fired, mix with water vapor in the gasses to form extremely corrosive hydrochloric or hydrofluoric acid an other corrosive byproducts. Dust drawn in may build up on the blower or clog the main burner ports. Also, be certain to examine the exterior area around the air intake of a direct vent installation for these contaminants.

AIR FOR COMBUSTION

FLAMMABLE ITEMS

Flammable items or pressurized containers or any other potentially hazardous articles must never be placed on or adjacent to the heater. Open containers of flammable material should not be stored or used in the same room with the heater or in the area of the exterior air intake of a direct vent installation. Direct venting **does not** eliminate the need to remove flammable or corrosives from the area surrounding the heater.

CONDENSATION

The average dewpoint of natural gas flue products is 127 °F. Propane flue products is 119° F. With 70° F ambient air temperature and 180° F stored water temperature, exhaust gas will be approximately 140° F. Recommended safe water storage temperature is 120° F.

NOTE: This unit can be vented using only PVC (Class 160, ASTM D-2241; Schedule 40, ASTM D-1785; or Cellular Core Schedule 40 DWV, ASTM F-891), Schedule 40 CPVC (ASTM F-411), or ABS (ASTM D-2661) pipe. The fittings, other than the TERMINATIONS should be equivalent to PVC-DWV fittings meeting ASTM D-2665 (Use CPVC fittings, ASTM F-438 for CPVC pipe and ABS fittings, ASTM D-2661/3311 for ABS pipe. If CPVC or ABS pipe and fittings are used, then the proper cement must be used for all joints, including joining the pipe to the Termination Tee (PVC Material). PVC Materials should use ASTM D-2564 Grade Cement; CPVC Materials should use ASTM F-493 Grade Cement and; ABS Materials should use ASTM D-2235 Grade Cement.
NOTE: for Water heaters in locations with high ambient temperatures (above 100°F) and/or insufficient dilution air, it is recommended that CPVC or ABS pipe and fittings (MUST USE SUPPLIED VENT TERMINAL) be used.

The extra high thermal efficiency of the BTH will result in condensation in the flue passage. The following answers common questions about this condensation.

Can I drain this condensation to the floor drain? The "Corrosion Resistance of Cast Iron Soil Pipe" by the Ductile Metals Association (formally the Cast Iron Soil Pipe Institute) states that:

"Internal corrosion of cast iron soil pipe and fittings can be caused by strong acids or other reagents having an acidity of pH 4.3 or less if allowed to contact cast iron pipe for an extended period of time without sufficient dilution to raise the pH valve about 4.3. By avoiding low pH discharges, internal corrosion problems can be limited or eliminated, assuring the owner many years of service."

WHAT ABOUT THE Ph VALUES OF CONDENSATE AND SODA POP?
The pH of the BTH condensate average 4.5 which is approximately 4 times less concentrated than the limit of 4.3 recommended by the DMA. Any water flow in the drain rapidly dilutes the condensate even more. A can of leading carbonated cola drink measured a pH of 2.5 which is 300 times more condentrated than the BTH condensate.

WHAT DOES THE Ph SCALE MEAN? The PH value is a measure of acidity or alkalinity. A pH of 7 is neutral. Numbers from 7 to 1 indicate increasing acidity and numbers from 7 to 14 indicate increasing alkalinity. The pH scale is similar to the Richter scale used to measure earthquakes. Each number indicates a change of 10 times the concentration of the previous value. A pH-6 is 10 times more concentrated than a pH-7, a pH-5 is (10x10) 100 times pH-7 and pH-4 is (10x10x10) 1,000 times pH-7, etc.

WHAT ABOUT CONDENSATE NEUTRALIZERS? Condensate neutralizers are usually not necessary. A condensate neutralizer is easy to make by filling a short length of 2" or 3" PVC pipe with landscape marble chips, capping it and installing it in series with the condensate drain of the equipment. Most commercial neutralizers are off the market because of poor demand for the product. Condensation from the exhaust vent piping and tank internal flue way must be allowed to drain. A "blocked flue" indication will often be your first indication that condensate is not draining.

VENTING

Equivalent Feet of Pipe Intake or Exhaust

VENT LENGTH TABLE			
Number of 90° Elbows	3" Minimum Pipe (Feet)	3" Maximum Pipe (Feet)	4" Maximum Pipe (Feet)
One (1)	7	45	115
Two (2)	7	40	110
Three (3)	7	35	105
Four (4)	7	30	100
Five (5)	7	--	95
Six (6)	7	--	90

4-inch PVC may be used for a MAXIMUM intake of ONE HUNDRED TWENTY (120) EQUIVALENT FEET and a MAXIMUM exhaust of ONE HUNDRED TWENTY (120) EQUIVALENT FEET. The maximum number of 90° elbows with the 4-inch venting is six (6) on the intake and six (6) on the exhaust. A 90° elbow is equal to five (5) equivalent feet of pipe. One (1) 90° elbow is equal to two (2) 45° elbows. Any venting configuration using less than 50 equivalent feet should use 3-inch venting. See Vent Length Table.

The 3-inch venting terminals (provided) must be used with the 4-inch venting by adding 4 x 3 reducing couplings at the venting terminals. A reducing coupling is also needed immediately after the condensate elbow (exhaust) and immediately before the 3-inch blower adapter (intake) if direct venting is installed. See Vent Length Table.

SUPPLY GAS

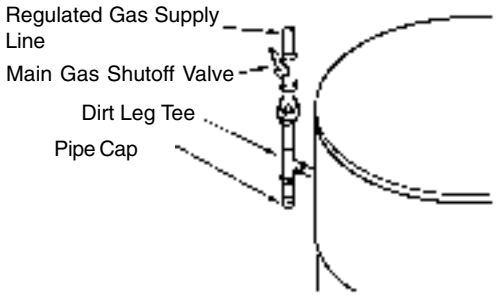
Gas Type	Minimum Inches W.C.	Maximum Inches W.C.
Natural	5	10.5
Propane	11	13.8

MANIFOLD GAS

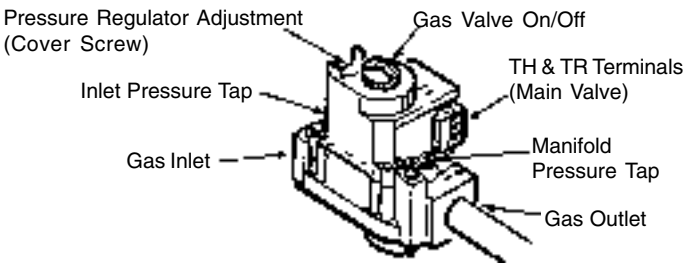
Gas Type	Minimum/Maximum Inches W.C.150/199	Minimum/Maximum Inches W.C. 120/250
Natural	3.5	4.0
Propane	10	10.0

NOTE: Pressure without capacity will result in lockout. Follow the piping guidelines in the instruction manual.

The **supply gas** pressure in normally measured at the dirt leg or at the inlet gas pressure tapping on the gas valve. This reading must be measured with 'flowing' gas.

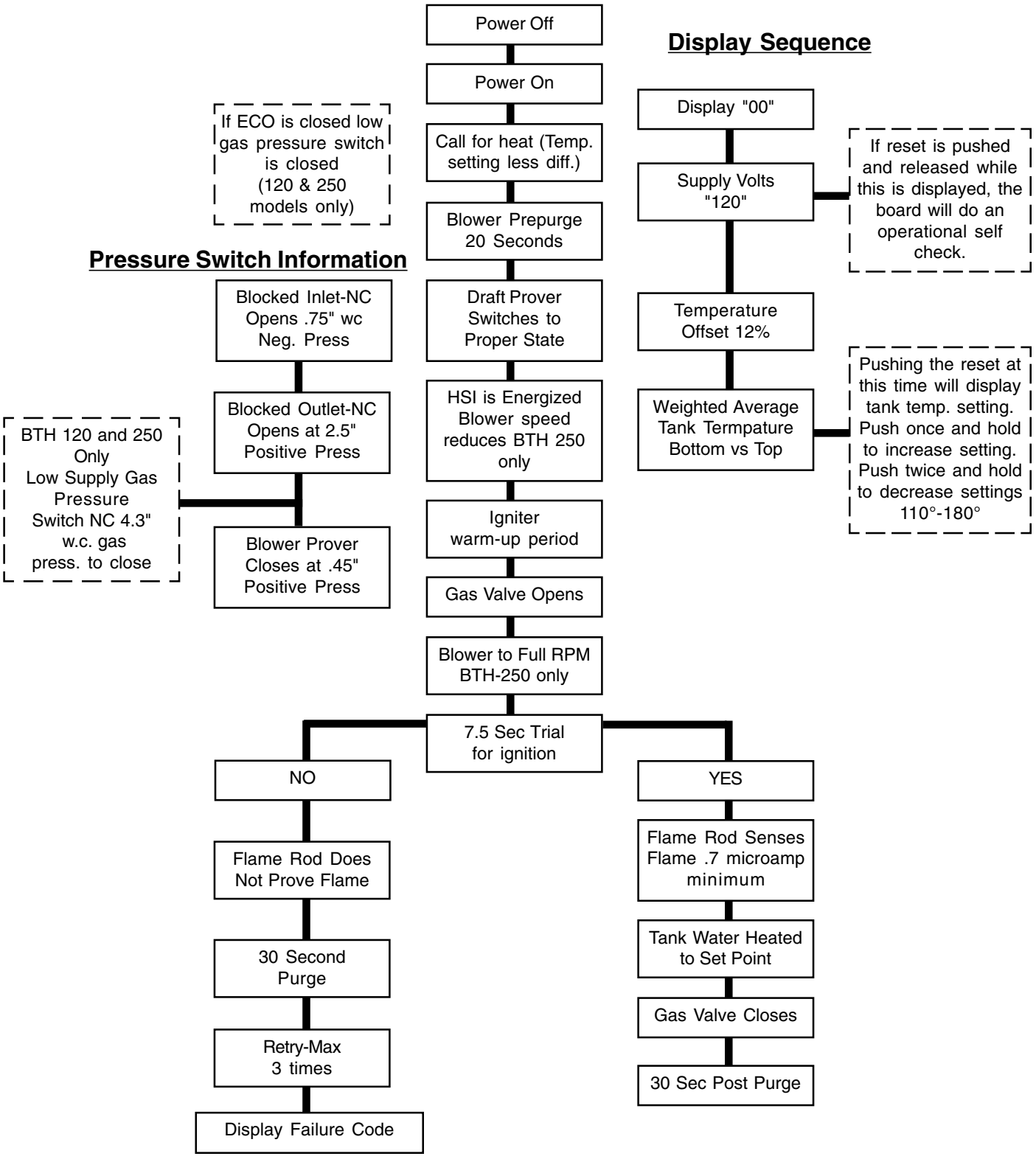


The **manifold gas** pressure is measured at the manifold pressure tap of the gas valve when the gas is flowing.



The gas valves used on all BTH water heaters are 24 volt AC combination step opening gas valves. They incorporate the main valve, and gas pressure regulators into one body.

BTH Sequence of Operation

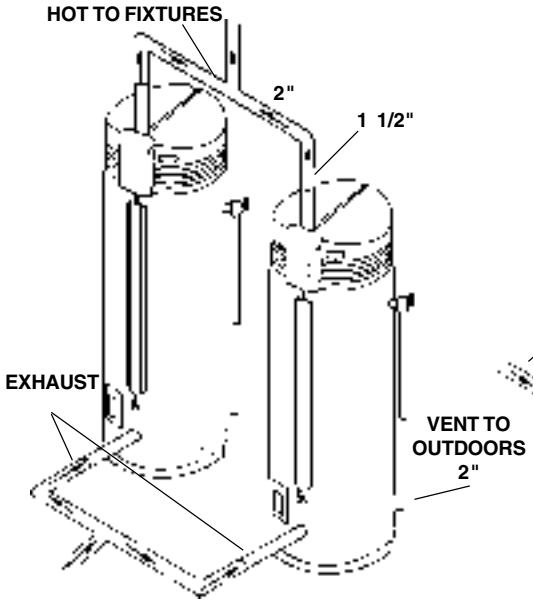

Power Off
Power On
Call for heat (Temp. setting less diff.)
Blower Prepurge 20 Seconds
Draft Prover Switches to Proper State
HSI is Energized Blower speed reduces BTH 250 only
Igniter warm-up period
Gas Valve Opens
Blower to Full RPM BTH-250 only
7.5 Sec Trial for ignition
NO
Flame Rod Does Not Prove Flame
30 Second Purge
Retry-Max 3 times
Display Failure Code
YES
Flame Rod Senses Flame .7 microamp minimum
Tank Water Heated to Set Point
Gas Valve Closes
30 Sec Post Purge
If ECO is closed low gas pressure switch is closed (120 & 250 models only)
Pressure Switch Information
Blocked Inlet-NC Opens .75" wc Neg. Press
Blocked Outlet-NC Opens at 2.5" Positive Press
Blower Prover Closes at .45" Positive Press
BTH 120 and 250 Only Low Supply Gas Pressure Switch NC 4.3" w.c. gas press. to close
Display Sequence
Display "00"
Supply Volts "120"
If reset is pushed and released while this is displayed, the board will do an operational self check.
Temperature Offset 12%
Weighted Average Tank Tempature Bottom vs Top
Pushing the reset at this time will display tank temp. setting. Push once and hold to increase setting. Push twice and hold to decrease settings 110°-180°

Note: If the lower temperature probe is defective or unplugged, display will show upper tank temperature. Heater may fire but stack.

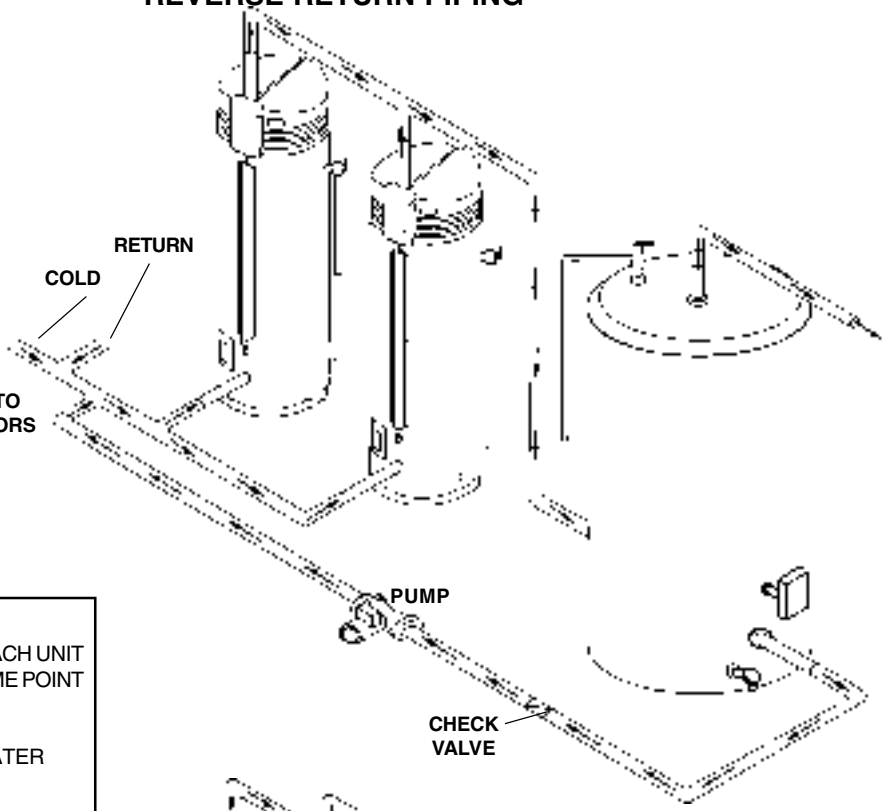
If upper high limit/tank temp. thermistor is defective or disconnected, cycling power off then on displays will be: 00, 120, 12, water temp at lower probe, flashing "04" code.

MULTIPLE UNIT - WATER PIPING

PARALLEL PIPING



REVERSE RETURN PIPING



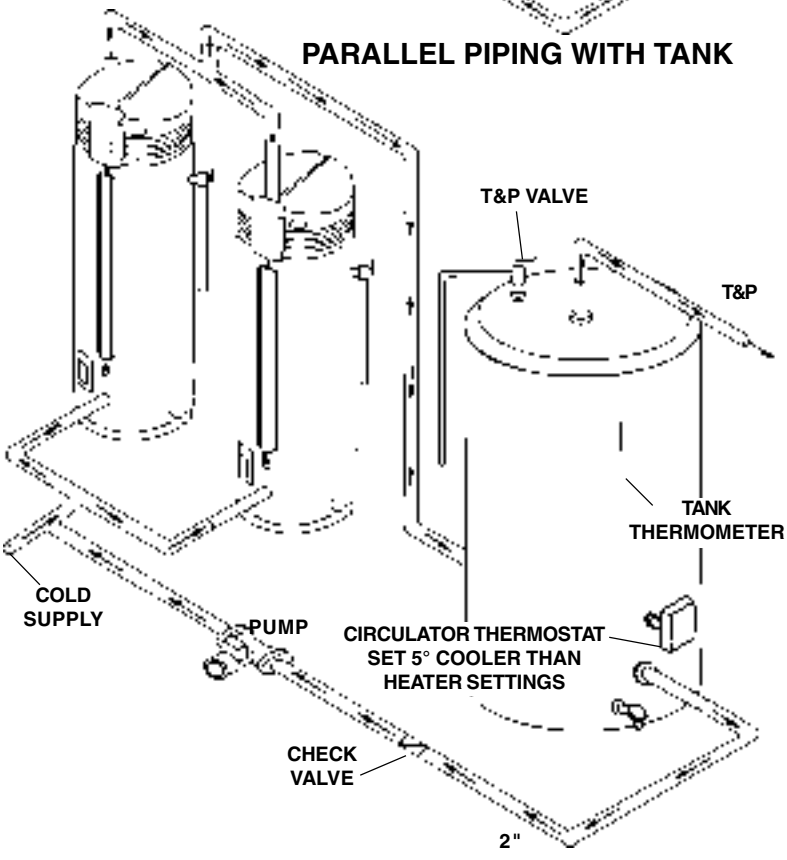
NOTES APPLY TO ALL SYSTEMS:
*ADD GATE VALVES TO INLET AND OUTLET OF EACH UNIT FOR ISOLATION FLEXIBILITY. LOCATE AT THE SAME POINT FROM TEE.

** ADD THERMAL EXPANSION TANK TO COLD WATER SUPPLY IF NECESSARY.

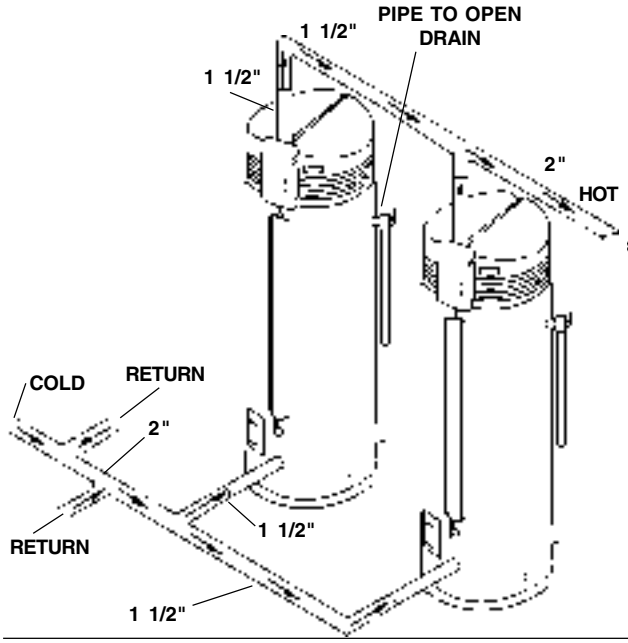
CONDENSATION HOSE MUST BE ALLOWED TO DRAIN.

NOTE: T&P VALVES MUST BE PIPED TO OPEN DRAIN OR PER LOCAL CODE.

PARALLEL PIPING WITH TANK



REVERSE RETURN PIPING WITH TANK



CYCLONE BTH

NORMAL INDICATIONS / READINGS

DURING CALL FOR HEAT

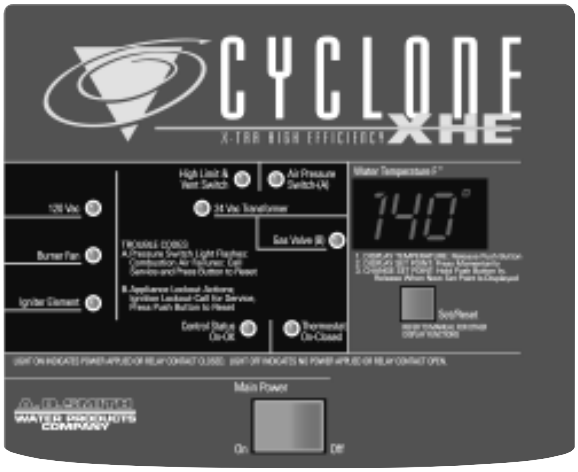
Tank temperature below control setting
(to check control setting, press reset button)

- On/off switch “on”

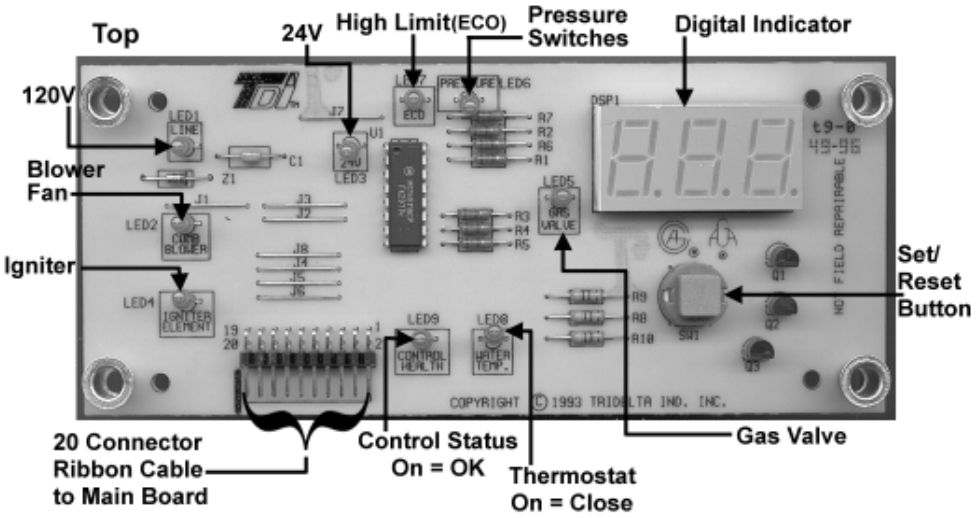
Note: Power must be on at least 4 seconds before reset can be pressed to indicate control setting.

- **Control panel indication lights “on”**
- On/off switch light “on”
- 120 VAC
- 24 VAC
- High limit
- Blower fan (while fan is running)
- Pressure switch (while blower is running)
- Control status
- Thermostat “on”
- Gas valve (during 4 second trial for ignition and while burner is on)
- Current average tank water temperature displayed

DISPLAY PANEL (CONTROL PANEL)



BTH DISPLAY BOARD INDICATIONS



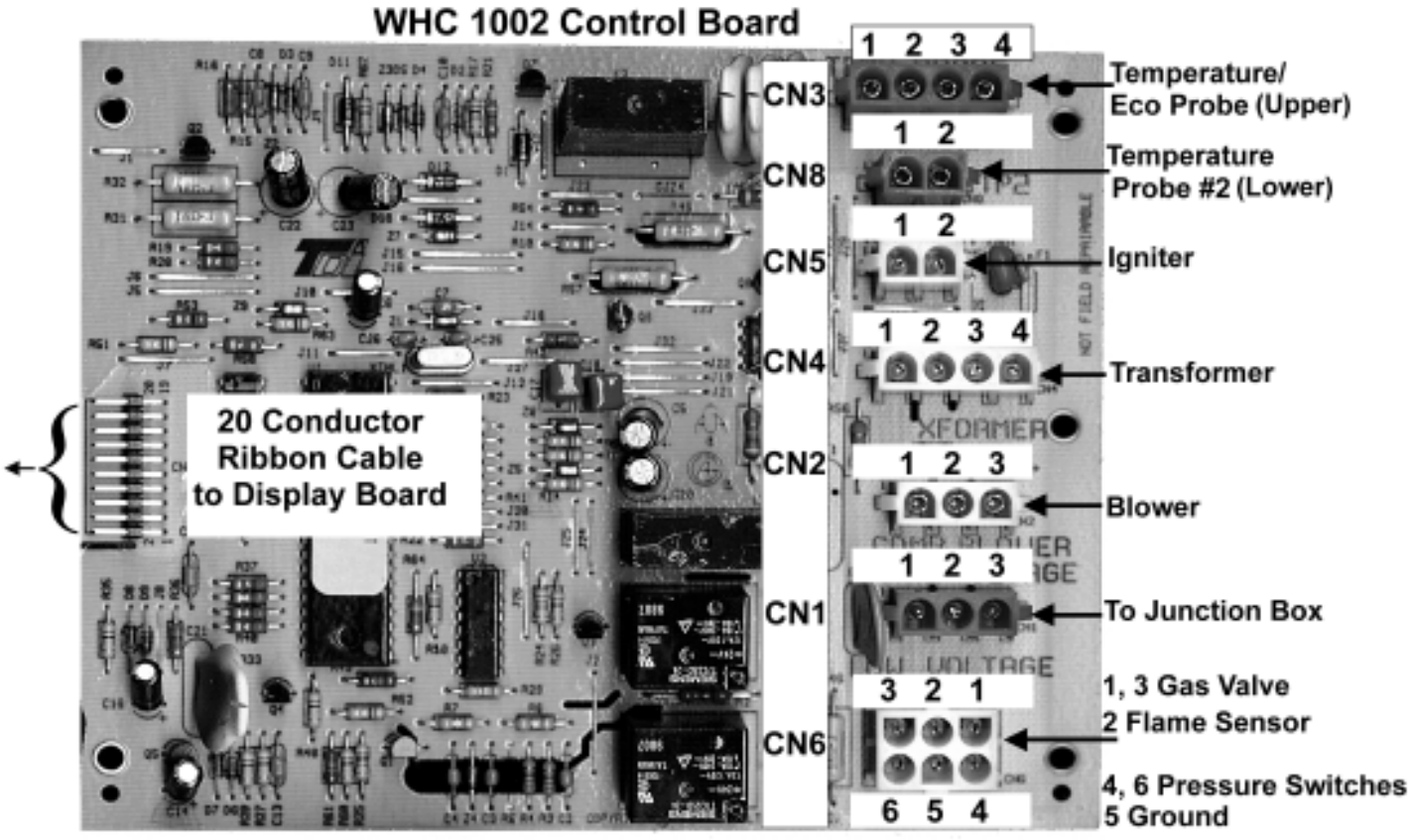
LED "On" indication implies that the device has power or has completed its function.

CYCLONE BTH
NORMAL INDICATIONS / READINGS

120 VAC present to ground and:
- Each black terminal of on/off switch
- CN1 black term 1
- CN 2 black term 1
- CN 4 black term 1
- CN 5 white term 1 (only while ignitor is heating)

Note: CN 6 black term 2 will give reading of 90-100 volts – ignore this reading.

24 VAC present to ground and:
- CN 3 red term 1 and red term 4
- CN 4 blue term 4
- CN 6 blue term 3, brown term 4, and brown term 6
- Each terminal of the 3 or 4 pressure switches



NORMAL INDICATIONS / READINGS

AFTER TANK IS SATISFIED

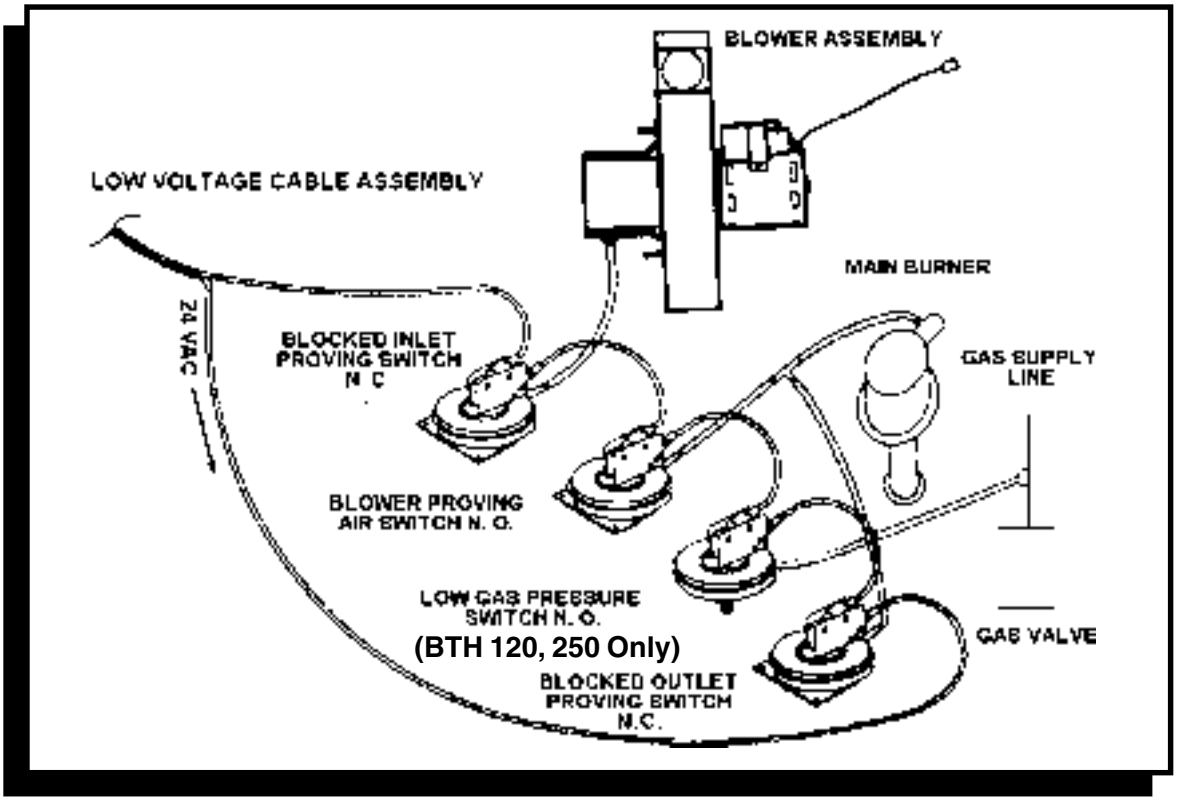
Tank temperature above control setting
- On/off switch is “on”

Normal conditions will be 120 volts present to ground and:
- Each black terminal of on/off switch
- CN 1 black term 1
- CN 4 black term 1

Note: CN 6 black term 2 (flame sensor) may display 90-100 VAC – this is a non-reading, ignore it

24 VAC present to ground and:
- CN 3 red term 1 and red term 4
- CN 4 blue term 4
- CN 6 brown term 4
- Blocked inlet switch – each terminal (tube connects to inlet of blower)
- Blower prover switch – upper terminal (this is the jumper wire from the blocked inlet switch)

Control panel indication light “on”
- On/off switch light
- 120 VAC
- 24 VAC
- High limit
- Control status
- Current (average) tank temperature will be displayed



TROUBLESHOOTING

PRE-SERVICE TIPS

CHECK THAT:

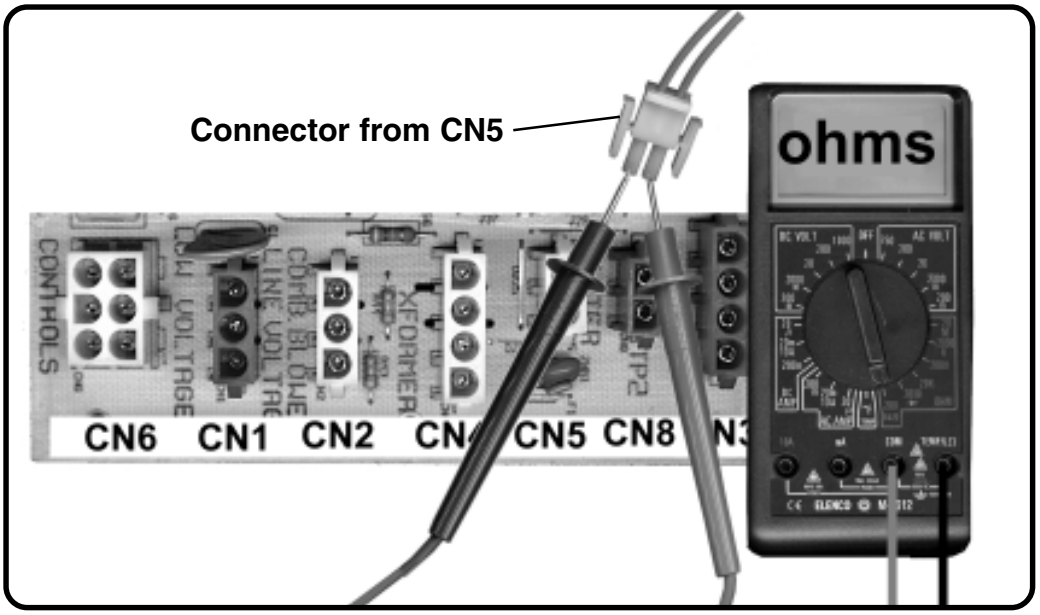
- **Tank is full of water**
- **Exhaust and intake vent do not exceed allowable limits**
- **All plugs into boards are secure**
- **Condensate hose is drained and open**
- **115-120 VAC is supplied to the heater (including polarity check a neutral to ground check results in "0" volts reading)**
- **Proper (natural or propane) gas is supplied**

CONTINUITY CHECKS

Condition:
After 20 second prepurge is complete
No main burner

- On/Off switch is off
- Igniter wires disconnected from CN5
- Multimeter set to "continuity check"
  2000 OHMS scale

STEP 1 - IGNITER CONTINUITY CHECK

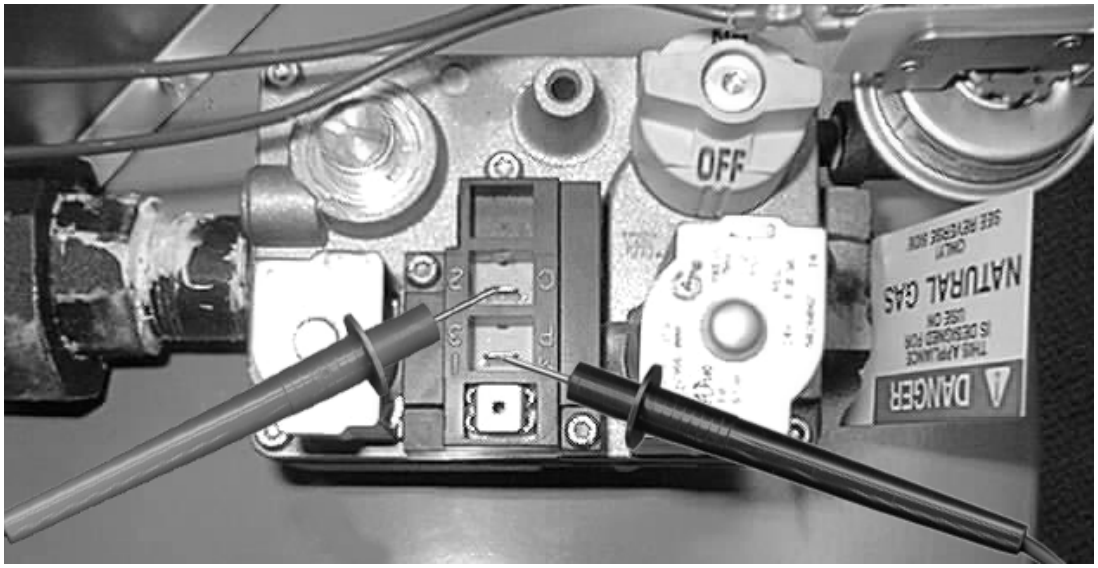


STEP 1. Check continuity through the leads of the igniter.

IF…	THE
a continuity range of 50-300 ohms is not present	rep
a continuity range of 50-300 ohms is present	rea

TROUBLESHOOTING

STEP 2 - CHECK CONTINUITY THROUGH THE VALVE COIL



STEP 2. Check Continuity Through The Valve Coil

- Power off
- Gas valve - coil continuity check
- Disconnect wires from gas valve
- Multimeter set to scale.

OHMS RESISTANCE TABLE		
BTH Model	**Gas**	**OHMS Resistance**
120	N	100
150, 199	N	560
150, 199	P	63
250	N	63

IF…
meter does not indicate +/- 7.5% of table
meter indicates +/- 7.5% of table

Usually a defective coil will be indicated by a "0" or "1" on the meter.

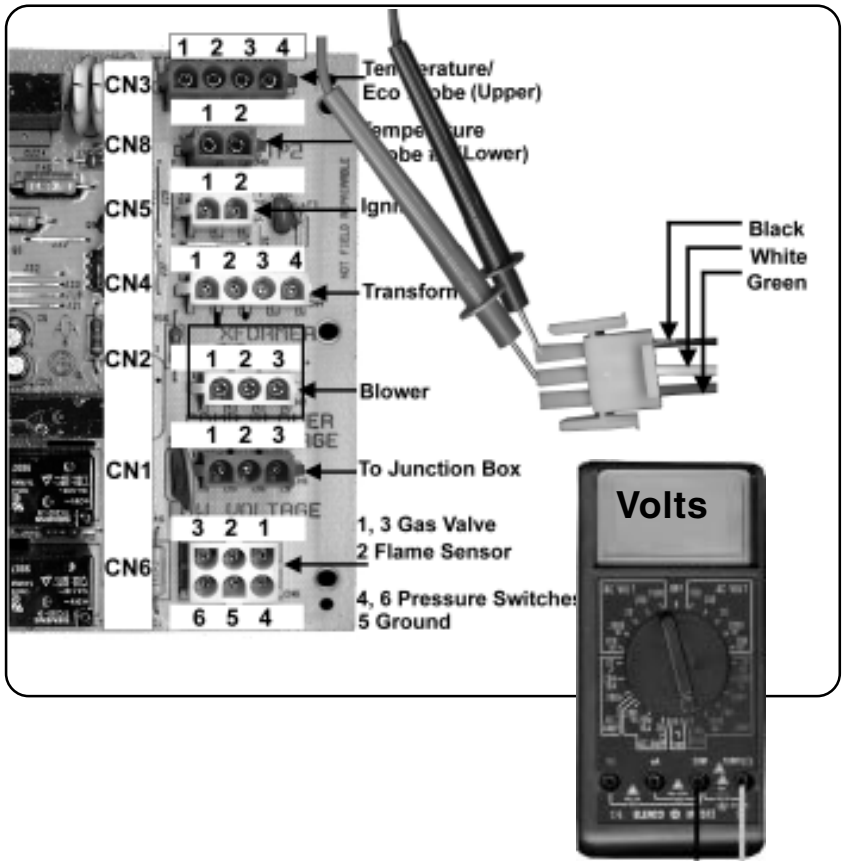
TROUBLESHOOTING

STEP 3 - CONTROL BOARD CHECK

STEP 3. 120 VAC SUPPLIED TO CONTROL BOARD - CN1 CONNECTION

- Disconnect plug from CN1 terminal
- Power switch "On" - 120 VAC indicator light should be "On"

Check for 120 VAC black wire terminal to white wire terminal on plug.



IF...
120 VAC is not present
120 VAC is present
Reattach plug to CN 1 terminal.

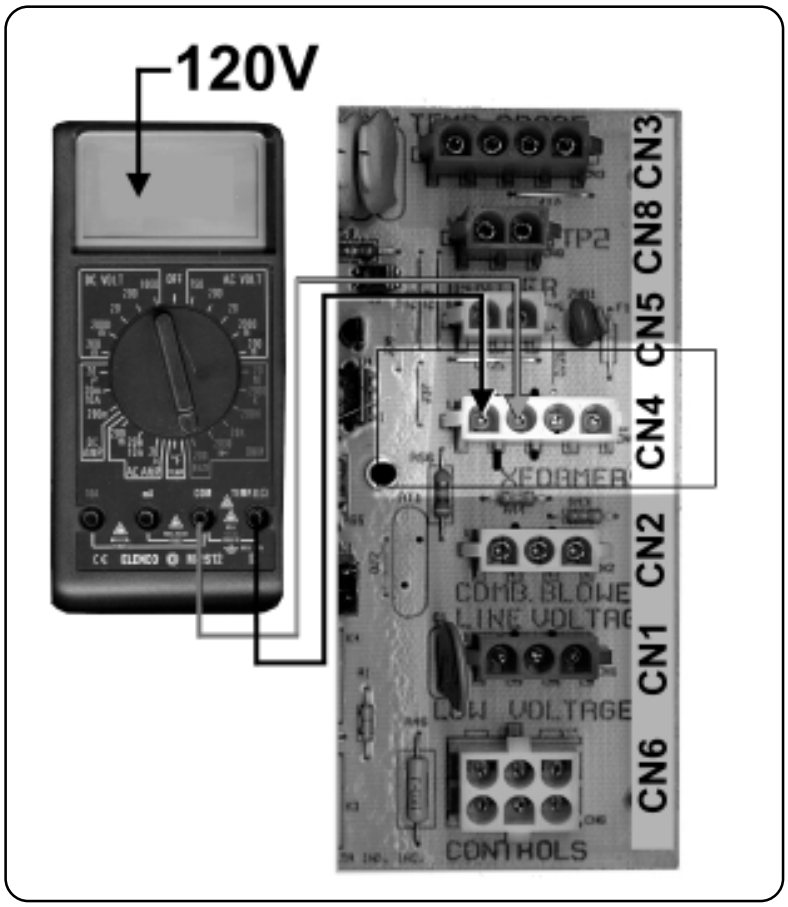
TROUBLESHOOTING

STEP 4 - TRANSFORMER TEST

STEP 4. 120 VAC SUPPLIED TO 24 VAC TRANSFORMER CN4.

- Disconnect CN 4 plug from board

Check for 120 VAC between the black terminal connect and white terminal connect on the control board.



IF…	THEN
120 VAC is not present	check CN 1 replace contr
120 VAC is present	go to Step 5.

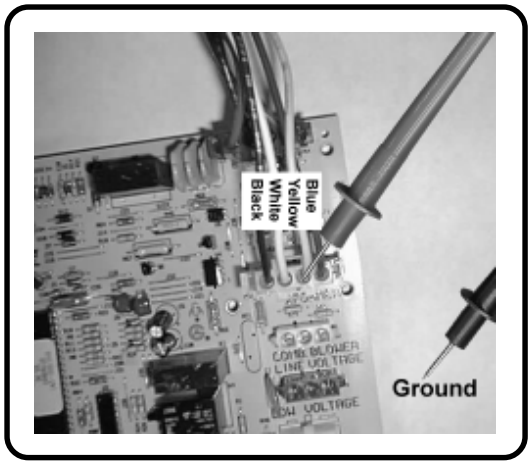
Reconnect the plug to CN 4 terminal.

TROUBLESHOOTING

STEP 5 - 24 VAC FROM TRANSFORMER

STEP 5. 24 VAC FROM TRANSFORMER
24 VAC transformer indicator light should be "on".
Insert probe into back of connect. Check for 24 VAC blue wire connect to ground and yellow wire connect to ground.

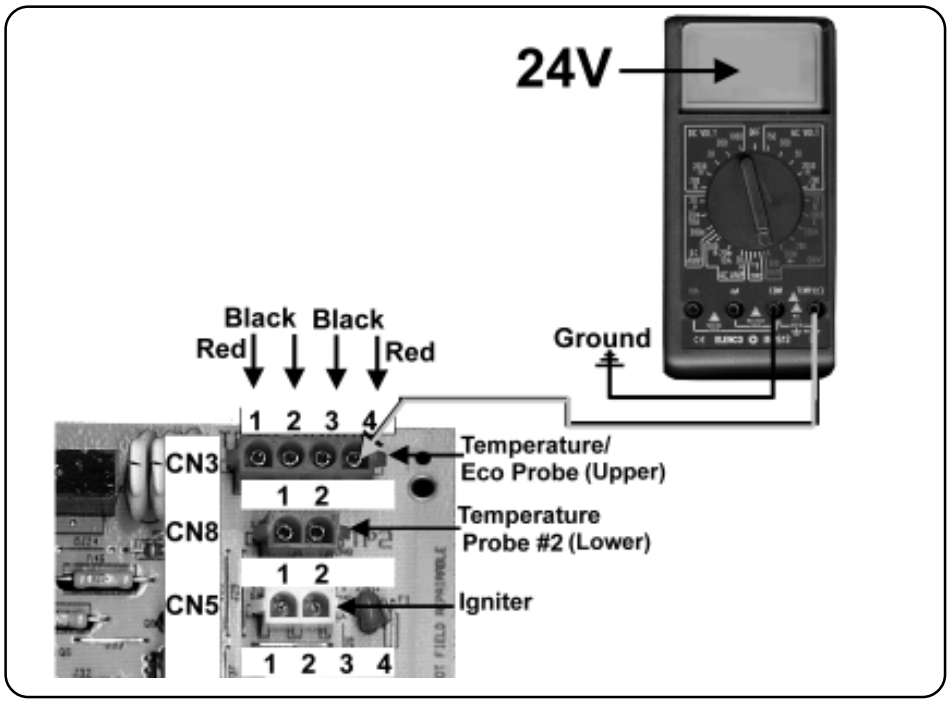
Meter Should Read 24 VAC



IF…	THEN
blue to ground does not have 24 VAC	replace trans
blue to ground does have 24 VAC	continue
yellow to ground does have 24 VAC	replace trans
yellow ground does not have 24 VAC	go to Step 6.

STEP 6 - CONTROL BOARD TEST

STEP 6. 24 VAC FROM CONTROL BOARD TERMINAL CN3 TO E.C.O.
Plug to CN 3 disconnected. (Energy Cutoff)
Check for 24 VAC red terminal 4 to ground on CN 3 terminal (red wires are the ECO wires).



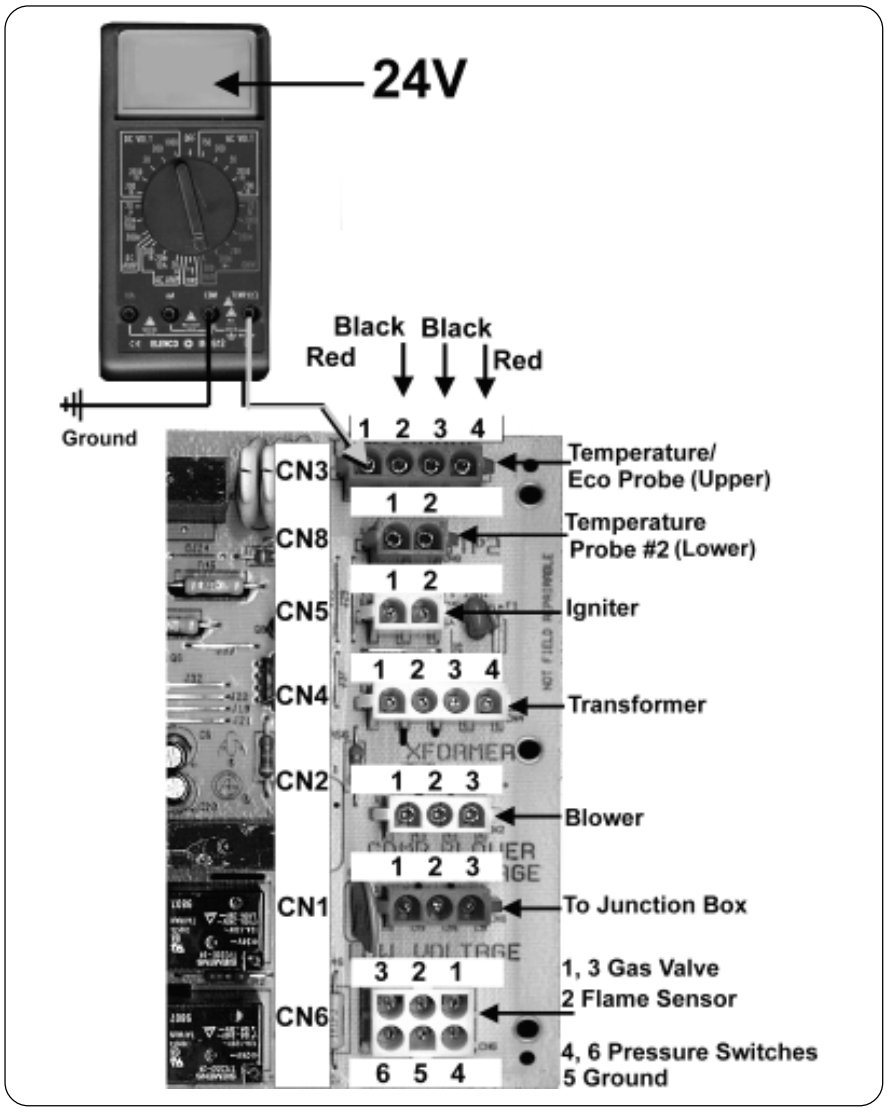
TROUBLESHOOTING

STEP 6. (continued)

IF…	THEN
24 VAC is not present	replace
24 VAC is present	go to S

STEP 7 - TEST FOR 24 VAC THRU ECO

STEP 7. 24 VAC THRU ECO (ECO IS NOT A THERMISTOR).
Reinstalled plug.
Check for 24 VAC from back of red 1 plug to ground.



IF…	THEN
24 VAC is not present	replace
24 VAC is present	go to st

Note: Resistance thru ECO - plug red 1 to plug red 4 - is .5 c

TROUBLESHOOTING

STEP 8 - TEMPERATURE THERMISTOR CHECK

STEP 8. TEMPERATURE THERMISTOR CHECK.

The ohm's resistance thru a thermistor is interpreted by the control board as a water temperature reading.

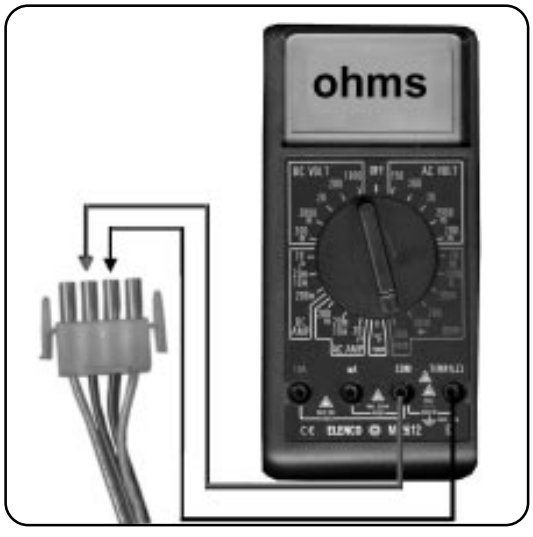
- Note tank water temperature on display board or tank a thermometer reading from the T&P valve and drain valve
- Disconnect plugs from CN 3 and CN 8
- Set multimeter to read "resistance" (20 K scale)

Check the ohm's resistance from black to black on the CN 3 plug and black to black on the CN 8 plug.

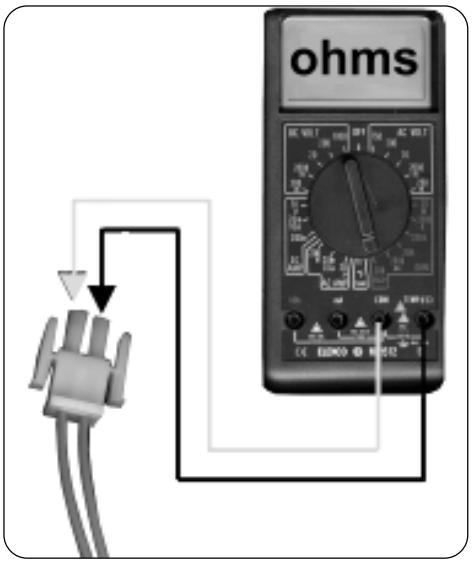
IF…	THEN
Ohm reading does not (approximately) correspond to table information	replace
Ohm reading does correspond (approximately) to the table information.	go to St

Water Temp		OHMS
°C	°F	Resistance
3	40	26,435
21	70	11,974
37.5	100	5,862
49	120	3,780
54.5	130	3,066
60	140	2,503
71	160	1,698
82	180	1,177

Note: Thermistors are very reliable unless a wire is cut or connection loose. A "bad" thermistor temperature sensor is unlikely to be the problem.



Upper Temperature Probe Plug



Lower Temperature Probe Plug

TROUBLESHOOTING

STEP 9 - BLOWER SPEED TEST

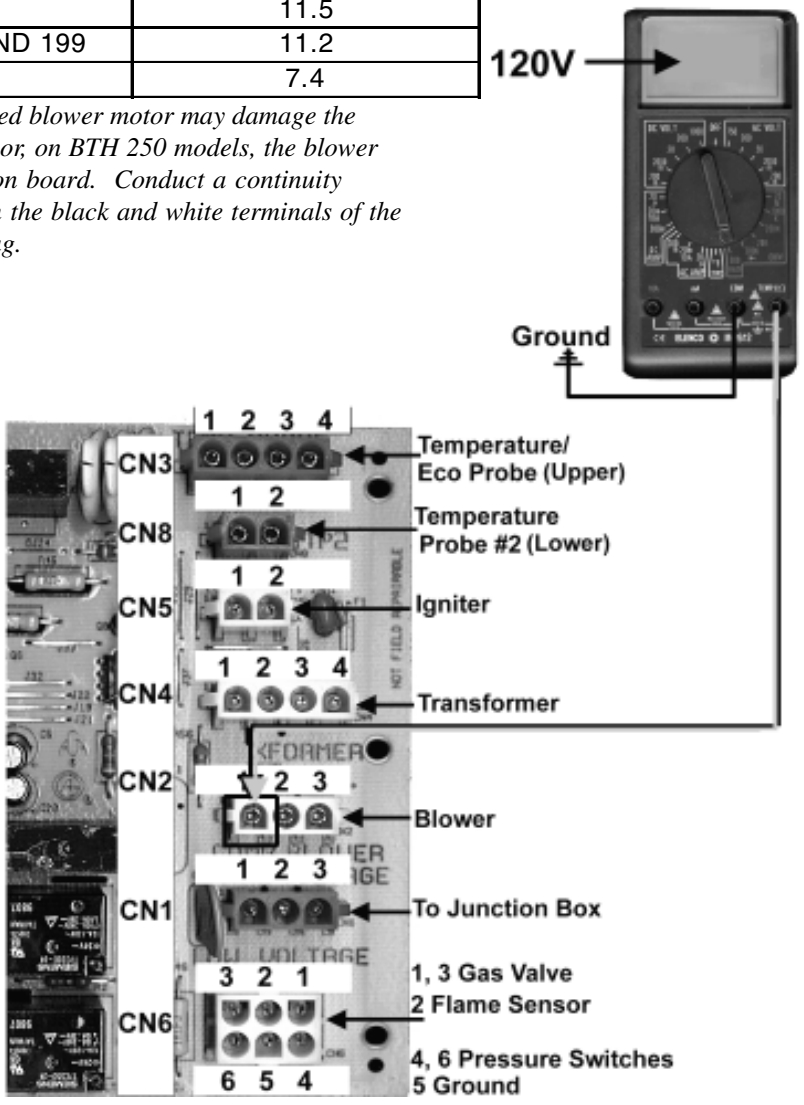
Reconnect plugs to board.
Blower operation check

- Tank must be calling for heat (minimum setting available is 80 F)
- Set multimeter to read 120 VAC

STEP 9. Check for 120 VAC from the back of CN 2 plug term 1 (black) to ground and from CN 2 term 2 (white) to ground.

Heater models - 966 or 967	Ohms resistance desired +/- 7.5%
BTH 120	11.5
BTH 150 AND 199	11.2
BTH 250	7.4

Note: A shorted blower motor may damage the control board or, on BTH 250 models, the blower speed reduction board. Conduct a continuity check between the black and white terminals of the C2 blower plug.



IF…	AND
terminal 1 to gnd. does not show 120 VAC	
terminal 1 to gnd. does show 120 VAC	blower is not runn
	blower is running

TROUBLESHOOTING

STEP 9A - BLOWER SPEED REDUCTION TEST

BTH 250 ONLY

HAS BLOWER SPEED REDUCTION BOARD

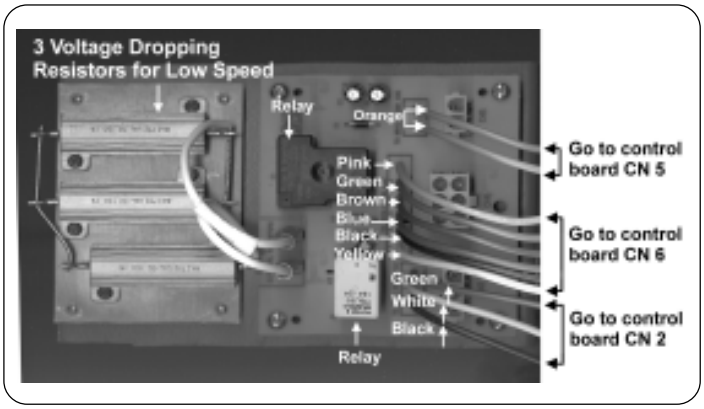
Blower wires (CN 2), igniter wires (CN 5), gas valve pressure switches and flame sense (CN6) plug directly into blower speed reduction board.

The cables from the blower speed reduction board plug into the control board recepticles CN 2, CN 5, and CN 6.

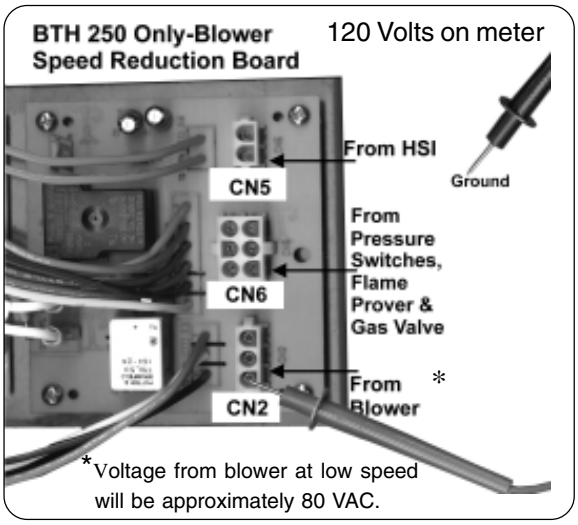
- 120 VAC present at CN 2 term 1 to gnd.
- Blower not running
- Tank is calling for heat

STEP 9A. Check for 120 VAC from blower speed reduction board plug (CN 2) term 1 (black wire) to ground.

IF…	THEN
120 VAC is not present	replace the blower s
120 VAC is present	replace the blower



STEP 9A



STEP 9B

STEP 9B - BLOWER TEST

STEP 9B.

IF …	THEN
blower runs but does not reduce speed during igniter warm up or stops during igniter warm up	replace blower spee
blower operates OK	go to Step 10.

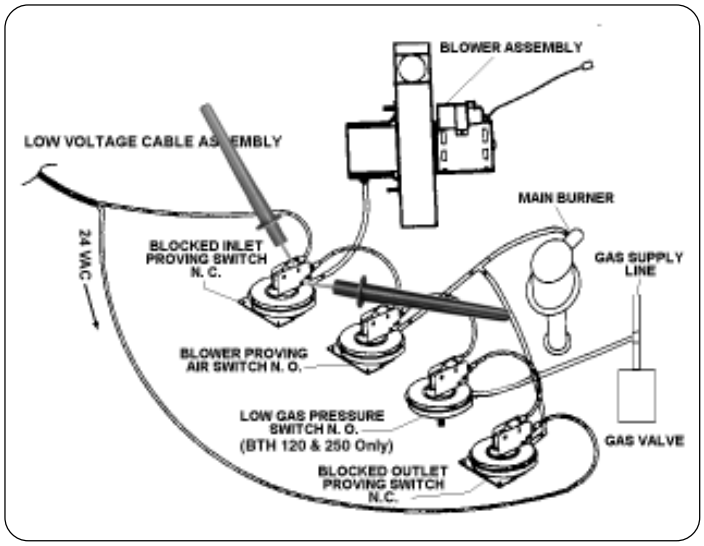
TROUBLESHOOTING

STEP 10 - CONTINUITY PRESSURE SWITCH TEST - ALL MODELS

Power Off

STEP 10. CONTINUITY CHECK OF EACH PRESSURE SWITCH - TERMINAL TO TERMINAL.
(Meter buzz indicates continuity)

IF…	THEN
Block inlet switch does not show continuity	replace
Block inlet switch does show continuity	continue
Blower proving switch does not show continuity	continue
Blower proving switch does show continuity	replace
Low gas pressure switch (BTH 120 and 250 only) does not show continuity	• checl • repla
Low gas pressure switch does show continuity	continue
Blocked outlet pressure switch does not show continuity	replace
Blocked outlet pressure switch does show continuity	continue


BLOWER ASSEMBLY
LOW VOLTAGE CABLE ASSEMBLY
MAIN BURNER
24 VAC
BLOCKED INLET PROVING SWITCH N. C.
GAS SUPPLY LINE
BLOWER PROVING AIR SWITCH N. O.
LOW GAS PRESSURE SWITCH N. O. (BTH 120 & 250 Only)
GAS VALVE
BLOCKED OUTLET PROVING SWITCH N.C.

24 VAC check through pressure switches – blower off.

- Power on
- Tank **not** calling for heat
- Multimeter set to check for 24 VAC

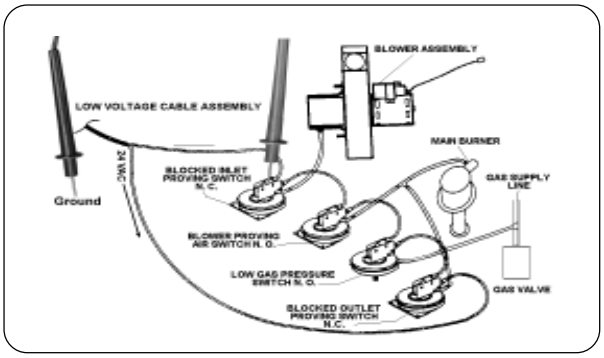
Note: Power flows from bottom terminal to top terminal of each switch – check wiring

TROUBLESHOOTING

STEP 11 - 24 VAC CHECK

STEP 11. 24 VAC CHECK –

Each terminal of pressure switch to ground; bottom (B) first then top (T) to ground next.



IF…	THEN
blocked inlet (B) to gnd does not have 24 VAC	check w
blocked inlet (B) to gnd does have 24 VAC	continue
blocked inlet (T) to gnd does not have 24 VAC	replace
blocked inlet (T) to gnd does have 24 VAC	continue
blower prover (B) to gnd does not have 24 VAC	check w
blower prover (B) to gnd does have 24 VAC	continue
blower prover (T) to gnd does not have 24 VAC	go to St
blower prover (T) to gnd does have 24 VAC	replace

STEP 12 - 24 VAC CHECK THROUGH PRESS SWITCHES

STEP 12. CONTINUATION OF 24 VAC CHECK THROUGH PRESS SWITCHES

- Tank **calling** for heat
- Blower on (See Table on Page 32 for Opening/Closing Pressures).

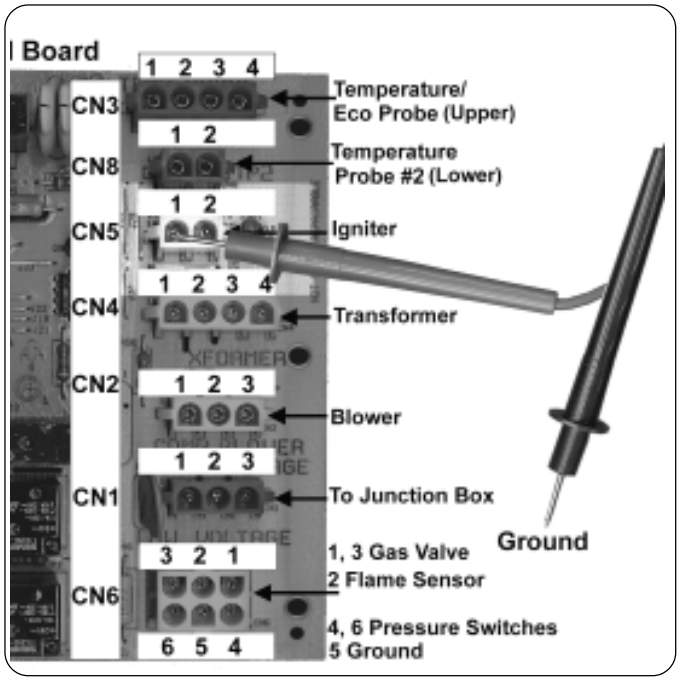
IF…	THEN
blower prover (T) to gnd does not have 24 VAC	• check for pos
	• air tubing is c
	• replace switc
blower prover (T) to gnd does have 24 VAC	continue.
(BTH 120 and 250 only)	
low gas press (B) to gnd does not have 24 VAC	check wire con
low gas press. (B) to gnd does have 24 VAC	continue.
low gas press (T) to gnd does not have 24 VAC	• check supply
	• connection tu
	• replace switc
low gas press (T) to gnd does have 24 VAC	continue.
blocked outlet (B) to gnd does not have 24 VAC	• check wire c
	• blower prover
	• if BTH 120 or
blocked outlet (B) to gnd does have 24 VAC	continue.
blocked outlet (T) to gnd does not have 24 VAC	• check for blo
	• check for pos
	• replace switc
blocked outlet (T) to gnd does have 24 VAC	continue to Ste

TROUBLESHOOTING

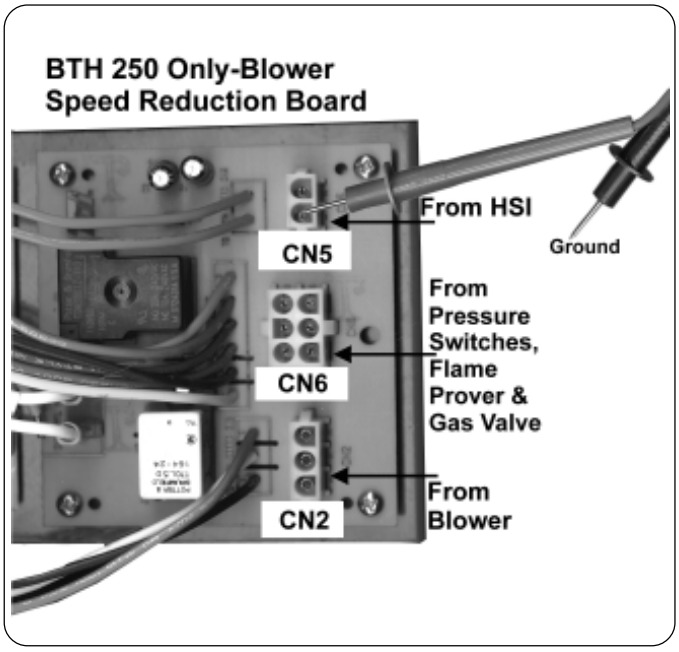
STEP 13 - VOLTAGE TEST ON 250 MODELS ONLY

STEP 13. VOLTAGE TEST TO IGNITER. HSI PLUG MAY BE REMOVED.
Check for 120 VAC on the control circuit board - plug CN 5, term 1 to ground.

IF…	THEN
120 VAC is not present	replace control b
120 VAC is present	igniter should be



STEP 13



STEP 13A

STEP 13A - BLOWER SPEED CHECK ON 250 MODELS ONLY

STEP 13A. ON BTH 250 MODELS ONLY.
Also check for 120 VAC on the blower speed board - CN 5 term 1 to ground.
(Blower should be at reduced RPM)

IF…	THEN
120 VAC is not present	replace b
120 VAC is present	continue
blower is not running or is at full RPM	replace b
blower is reduced RPM	go to Ste

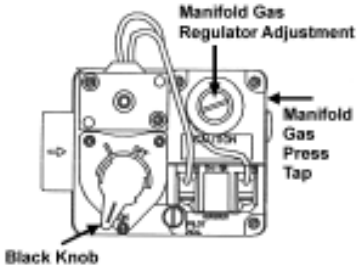
TROUBLESHOOTING

STEP 14 - SUPPLY GAS PRESSURE TEST

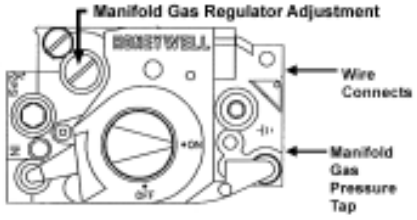
STEP 14. CHECK SUPPLY GAS PRESSURE

Attach monometer or gas pressure gauge to pressure tap on gas valve or use adapter to check pressure ahead of valve as near as possible to valve.

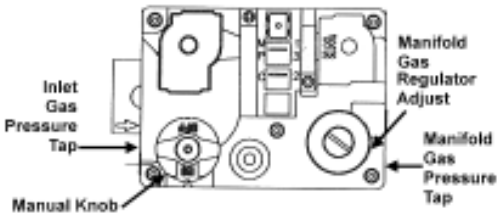
BTH 150, 199 Propane
BTH 250 Natural
Gas Valve



BTH 150, 199 Natural
Gas Valve



BTH 120 Natural
Gas Valve



IF…	THEN
supply gas pressure is not between 4.5 and 14" w.c. natural gas or 11.0 and 14" w.c. propane	adjust sup minimum i
proper supply gas pressure is present	go to Step

STEP 15 - GAS PRESSURE MANIFOLD TEST

STEP 15. CHECK GAS PRESSURE TO MANIFOLD

IF…	TH
•pressure is not 3.5" w.c. ± 0.2" on natural gas or 10.0" on propane gas on BTH 155, 199 •pressure is not 4.0" w.c. ± 0.2" natural gas or 10.0" propane on BTH 120 or 250	rep
•pressure is 3.5" w.c. ± 0.2" natural gas or 10.0" w.c. ± 0.2" propane on BTH 155 or 199 •pressure is 4.0" w.c. ± 0.2" natural gas or 10.0" ± 0.3" propane on BTH 120 or 250	ign

COMPONENT PART INFORMATION

GAS VALVES

Model	AOS PT#	Voltage
W.R. 36E36-319	192966-0 Nat.	24 VAC
Hnwl VR8305M-4009	192797-Nat.	24 VAC
W.R. 36C68-814	192454-1 Prop	24 VAC
W.R. 36C68-809	1922454-0 Nat.	24 VAC

HSI		
Flame Rod	AOS PT#	Flame S
	192478	.7 Micro (μ)
Hot Surface Igniter (HSI)		
	AOS PT#	Voltage
	192478	120 VAC

ORIFICE TABLE

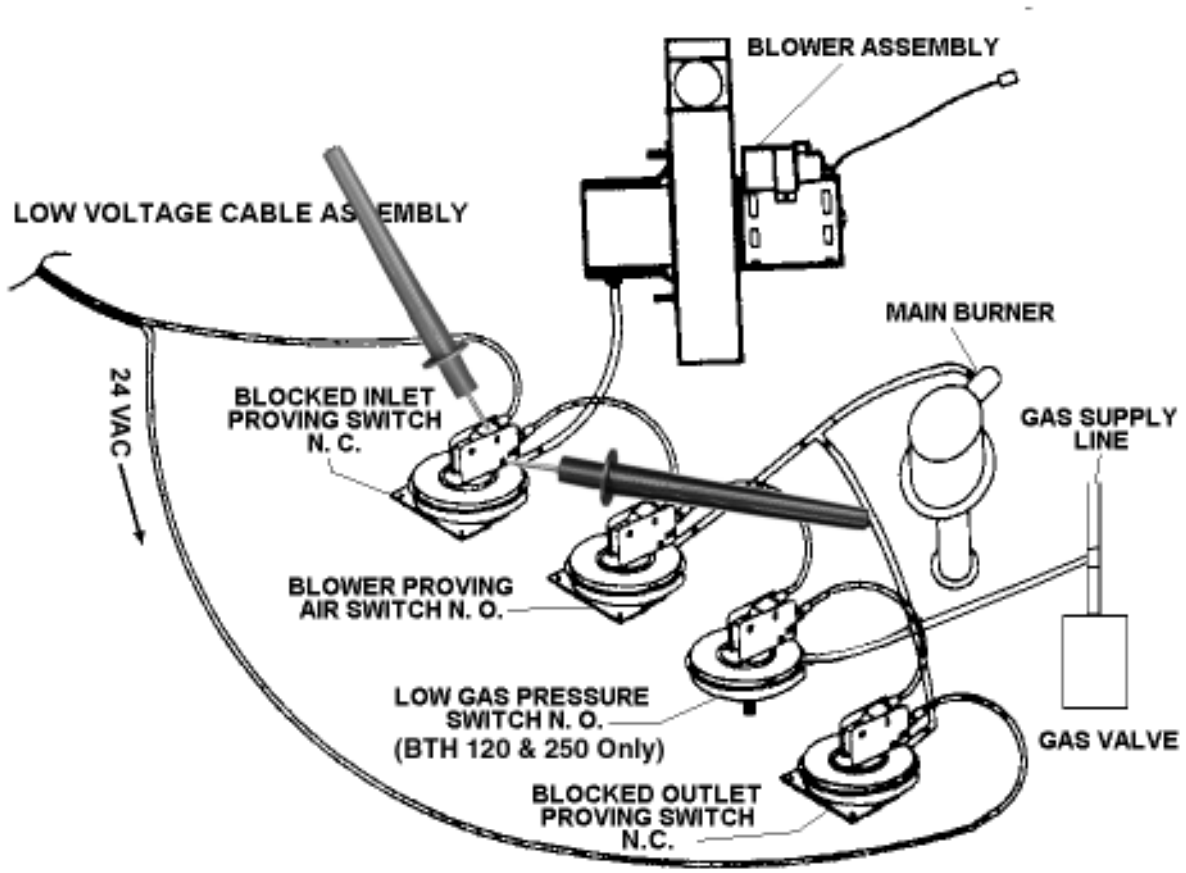
		Orifice Table
BTH Model	Main Burner Orifice No.	Main Orifice Size Inches
199	192477-0	0.304
150	192477-1	0.235
250	192477-2	0.360
120	192477-3	0.204
199 Prop	192477-4	.166*
150 Prop	192477-5	.141*

*-4 and -5 Red plated for propane.

** -4 and -5 stamped with "P" for propane

Note: Hex head of main burner orifice is upstream end - gas flows ou

PRESSURE SWITCHES

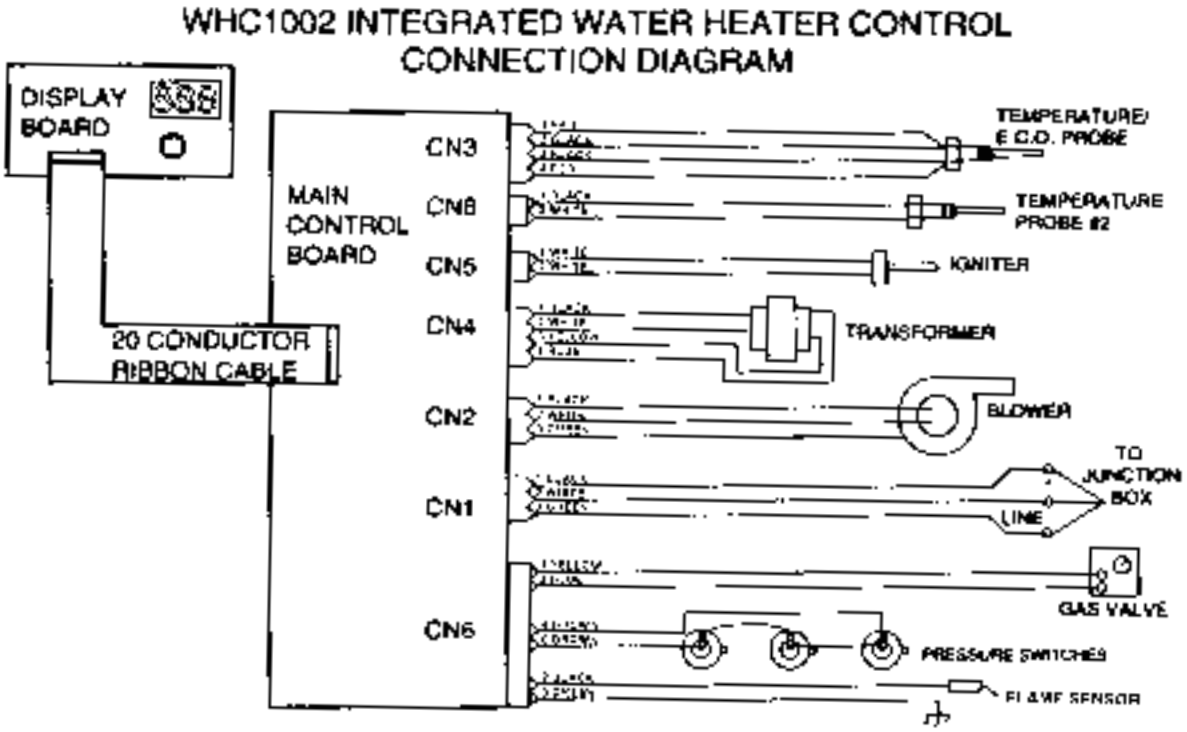

BLOWER ASSEMBLY
LOW VOLTAGE CABLE ASSEMBLY
MAIN BURNER
24 VAC
BLOCKED INLET PROVING SWITCH N. C.
GAS SUPPLY LINE
BLOWER PROVING AIR SWITCH N. O.
LOW GAS PRESSURE SWITCH N. O. (BTH 120 & 250 Only)
GAS VALVE
BLOCKED OUTLET PROVING SWITCH N.C.

Model	Series	Inches	
		Blocked Inlet N.C. Opens at:	Blow Prover Closes
BTH 120	966	-1.0	0.4
BTH 120	967	-2.0	0.4
BTH 150	960	-	0.4
BTH 150	962	-0.75	0.4
BTH 150	966	-1.6	0.4
BTH 150	967 (Prop.)	-1.6	0.4
BTH 199	960	-	0.4
BTH 199	962	-0.76	0.4
BTH 199	966	-0.77	0.4
BTH 199	967 (Prop.)	-2.0	0.4
BTH 250	962	-0.95	0.4
BTH 250	966	-0.77	0.4

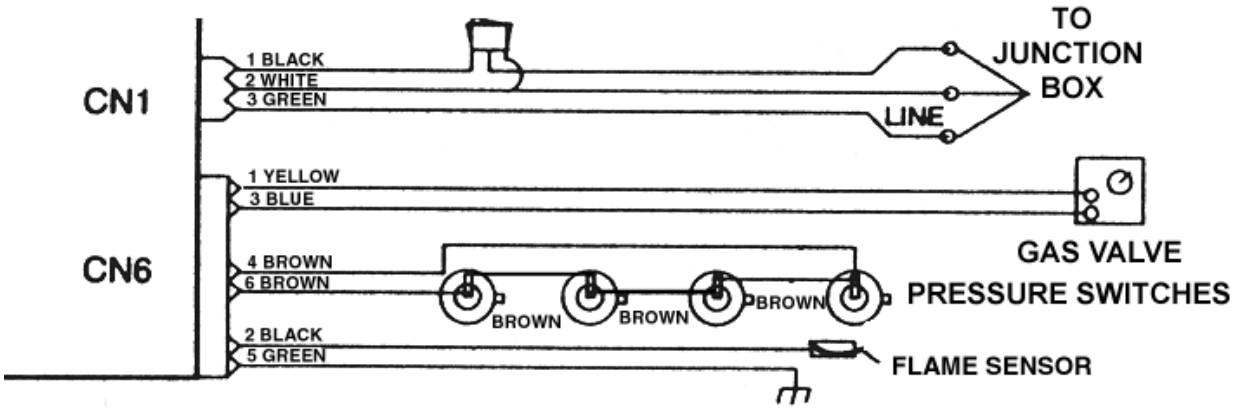
N.C. = normally closed
N.O. = normally open

WIRING CONNECTIONS

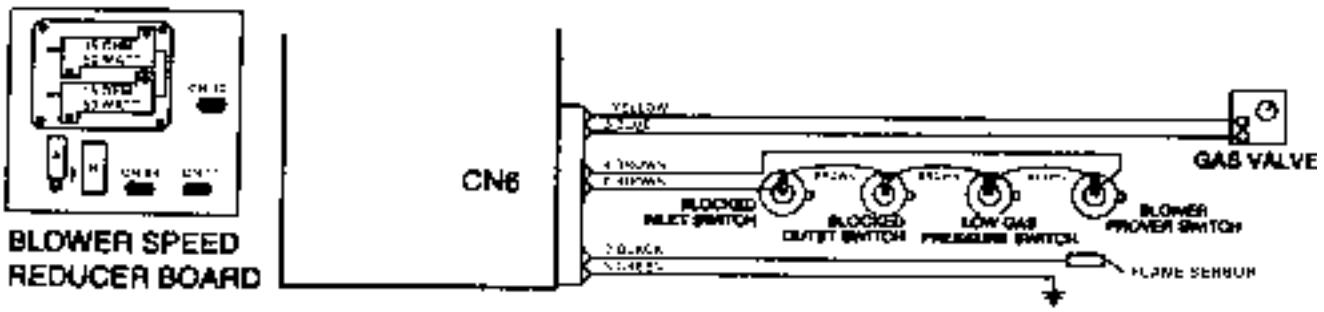
BTH 150, 199 DIAGRAM



BTH 120 and 250 DIAGRAM



BTH 250 DIAGRAM



SERVICING AIDS

1. This type product is polarity sensitive. Be certain that your electrical supply wire neutral has no voltage.
2. This unit will produce condensation--quite heavily at times. The outlet drain hose must be allowed to drain. Exhaust Vent piping must also drain condensate. Code 11 error would imply that these must be checked.
3. If this unit is located in a cold climate, take steps to ensure that exhaust vapors are not inhaled by the air intake vent. Terminate both vents in the same area but maximize the distance between them.
4. Do not combine vent these units.
5. Pushing the reset button at random times may alter setting of the control. Note the sequence of operation comments on when to push this button.
6. If you make a setting change, cycle the heater with this new setting to lock it into memory.
7. The first items to check on a service call
   a. Correct venting installation
   b. Drainage of condensate from hose and exhaust vent pipe
8. BTH models are certified to 6.800 ft. ASL with the standard orifices--air and gas
9. The temperature display board indicates average tank water temperature. If one tank sensor is "open," the indicator will display the active sensor temperature. (Because the top tank sensor also contains the high limit-24V-sensor, disconnecting this from the control board results in an error code (04).)
10. Temperature and pressure relief valve operation. Weeping usually indicates thermal expansion. Large volume discharge usually indicates excessively hot water operation.
11. BTH models are well within decimal level limits but, if you desire to lower the installation level approximately 6 decibels a muffler (AOS No. 192718) may be installed in the exhaust vent.

QUESTIONS AND ANSWERS

Q: How much electrical power is required for a BTH water heater?

A. The BTH models draw approximatley 5.0 Amps Max.

Q. When should BTHs be delimed?

A. Many variables affect the lime build up process including:
- *Water temperature* - the amount of lime accumulation during the same period of time will be nearly 2 times greater if water is stored at 140 degress F than at 120 degrees F. A 180° setting may accumulate seven times more lime - in a period of time - than a 140° setting.
- *Volume of water* - the more gallons flowing through the BTH, the more rapid the accumulation.
- *Hardness* - the harder the water the quicker lime build up occurs. 1 to 3.5 grains per gallon is "soft," 3.5 to 7 grains per gallon is "moderate," 7 to 10.5 grains per gallon is "hard" and 10.5+ grains per gallon is "very hard." (An aspirin is about 5 grains. One grain is equal to 17.1 parts per million.)

A. Deliming should be done when a slight rumbling or popping sound is detected when the main burner is on. Check for accumilation through the clean-out opening.

Q. What effect will lime build-up have on the BTH water heater?

A. One eighth inch of scale buildup may reduce efficiency as much as 22%; a 1/4 inch buildup, as much as 38%.

Less efficient heat transfer means more heat exchanger expansion/contraction stress and premature leakage.

Because heat transfer to the water is made through a (relatively) small diameter, coil type exchanger tube, expansion and contraction as well as the shape of the exchanger greatly reduces buildup on the heat transfer surface. The bottom of the tank should be checked for dislodged accumulation.

Q. Anode rodes (4) provide additional protection against corrosion. When should these be replaced?

A. When large gauges or pits appear in the anodes, replace them.

Q. How often should these anodes be inspected?

A. Approximately every six months.

BTH ERROR CODES

BTH COMMON ERROR CODES -	
Code 04 - ECO Open	The hi-limit has been tripped or is malfunctioning -- Try to reset the ECO. Test to see if ECO is malfunctioning. Also make sure to test the lower temp probe for continuity. If it has failed the unit may be stacking
Code 02 - Ignition fail after 3 attempts	Has failed to ignite after 3 tries -- Could be a gas pressure problem, condensate tee, or venting.
Code 05 - Open Temperature Probe	Open temperature probe -- the upper temperature probe is malfunctioning (not the lower probe). Test for continuinty thru upper temp probe. An open circuit means the upper probe and its wiring needs to be replaced. If continuity is present, check connections to replace board.
Code 11 - Pressure switch fail	Pressure switch fails to close/open after 5 minutes -- Check condensate tee and venting. Jump switch temporarily, or test wiht manometer. 90% of the time its going to be a problem with condensation or venting installation problem. (too long, too short, manifold venting)
Codes higher than 199 -	These are software errors -- the electric noise is causing unnecessary lockouts. Replace the board.
Solid "00" or "01" - Condensate tee	The first number which comes up is "00". If the heater is stuck on the startup process, you'll get the solid 00. This is an indication that the condensate tee is clogged.
OTHER SERVICE HINTS	
Condenstate tee	BTH produces quite a bit of condensation. If the tee is not installed properly or kinked or plugged or is going up hill, the venting will fill up quickly and the problem may be registered as another error.
Chattering gas valve	Low or High supply gas pressure. Possibly plugged condensate hose.
Noisy heater	Short runs on the venting can increase noise. By adding a few elbows in the venting or extending the run, the noise will diminish. The muffler will help. Using 4" vent - if possible - may also help.

SERVICE CHECKLIST

This is not intended to be an all-inclusive list of the problems that the Service Agent may encounter. Any item checked "no" on this list should be thoroughly investigated and corrective action taken, if required.

SERVICE AGENT: _____ INSTALLATION DATE: _____
MODEL NUMBER: _____ SERVICE DATE: _____
SERIAL NUMBER: _____ LOCATION ADDRESS: _____
PHONE ( ) _____ - _____

GAS TYPE - CHECK ONE
NATURAL _____
PROPANE _____
PROPER GAS VALUE VERIFIED YES ___NO___

I. CHECK CLEARANCE (CIRCLE ANSWER)
A. Are exterior clearances adequate _____ yes no
B. Are interior clearances adequate _____ yes no
Comments: _____
_____

II. CHECK MAKEUP AIR REQUIREMENTS
A. Is the quality of make-up air adequate? _____ yes no
Comments: _____
_____

B. Is the quantity of make-up air adequate? _____ yes no
Comments: _____
_____

III. GAS PRESSURE (FILL IN BLANK) - ALL UNITS ON.
A. Supply gas pressure ___ inches of w.c. (flowing)
B. Manifold gas pressure (main burner) ___ inches of w.c. (flowing)
Comments: _____
_____

IV. VENTING (CHECK)
A. Acceptable equivalent footage _____ yes no
B. Proper material _____ yes no
C. Proper exterior installation _____ yes no
D. Condensate will drain _____ yes no
Comments: _____
_____

V. WATER PIPING
Is the system properly sized? _____ yes no
Is the system properly installed? _____ yes no
Are there any water leaks? _____ yes no
Does the installation have a recirculating system? _____ yes no
If so, is it operational? _____ yes no

VI. SAFETY
A. Air
If exhaust is blocked will unit lockout? _____ yes no
If air intake is blocked will unit lockout? _____ yes no

B. Water Temperature
- Is the thermostat adjusted to the lowest acceptable temperature? _____ yes no
- Does the installation have a mixing valve? _____ yes no
- If so, is it operational? _____ yes no
- What is the outlet temperature of the mixing valve? _____ yes no

NOTE: To minimize the risk of scalding, the manufacturer recommends storing water at 120°F.

Is a properly rated temperature and pressure relief valve installed? _____ yes no
Is there a properly installed expansion tank? _____ yes no
Should there be? _____ yes no

C. Electrical
Is the 120 VAC electrical powers supply properly wired? (including polarity) _____ yes no
Are all the BTH control covers in place? _____ yes no
Is the 120 VAC electrical power supply properly fused? _____ yes no

D. Flammables
Are flammable materials located in the area of the water heater? or air intake? _____ yes no
Are flammable vapors located in the area of the water heater? or air intake? _____ yes no

E. Gas
If the gas supply is reduced or turned off will the unit turn off? _____ yes no
Comments: _____
_____

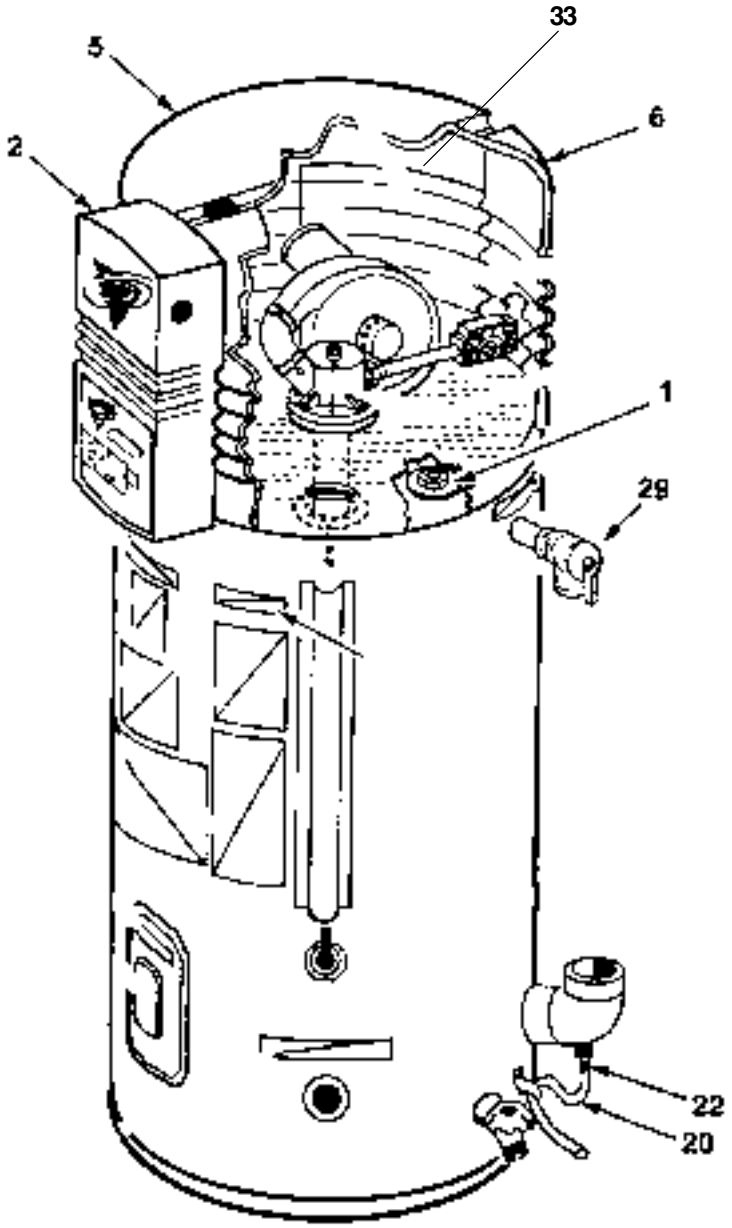
[This service checklist may be photo copied to assist with BTH service calls].

A.O. SMITH
WATER PRODUCTS COMPANY

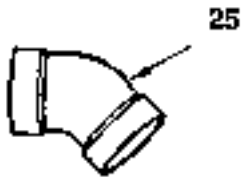
GAS

COMMERCIAL WATER HEATER PARTS LIST

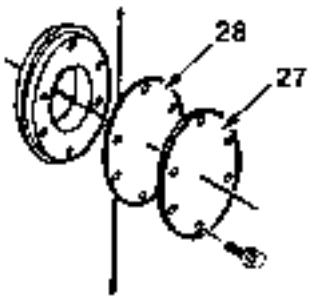
CYCLONE XHE® MODEL BTH-120
SERIES 966
(PARTIAL PARTS LISTING)



EXHAUST TERMINAL



DIRECT VENT INTAKE TEE



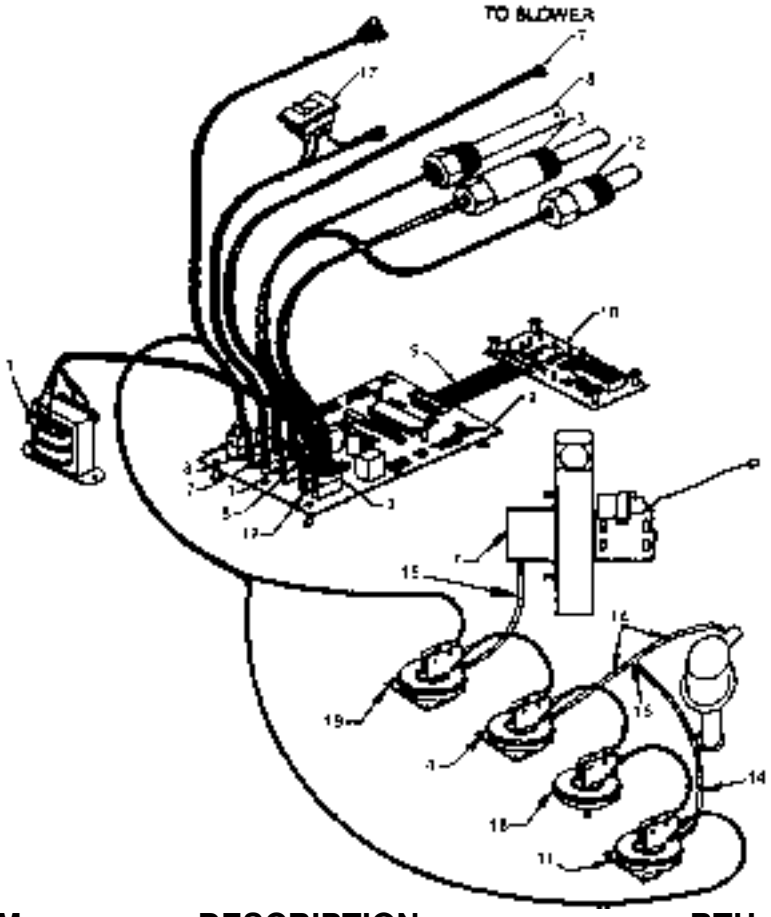
CLEAN OUT ASSEMBLY

A.O. SMITH WATER PRODUCTS CO., INC.
PARTS INFORMATION
PHONE: 1-800-433-2545
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODEL
BTH-120 WATER HEATER PARTS LIST (PARTIAL)
SERIES 966

ITEM	DESCRIPTION	BTH-120
1	Anode	043817-029
2	Panel, Front	192935-000
5	Panel, Left Side	193237-000
6	Panel, Right Side	193238-000
20	Condensate Hose	181864-072
22	Barb, Hose	181863-000
24	Exhaust Terminal	192815-000
25	Intake Terminal	192815-000
27	Plate, Pressure	099037-000
28	Gasket	099038-000
29	Valve, Relief	192467-000
30	Clamp, Hose, Nylon Snap	191794-001
33	Panel, Back	193239-000
36	Instructional Manual	194119-000

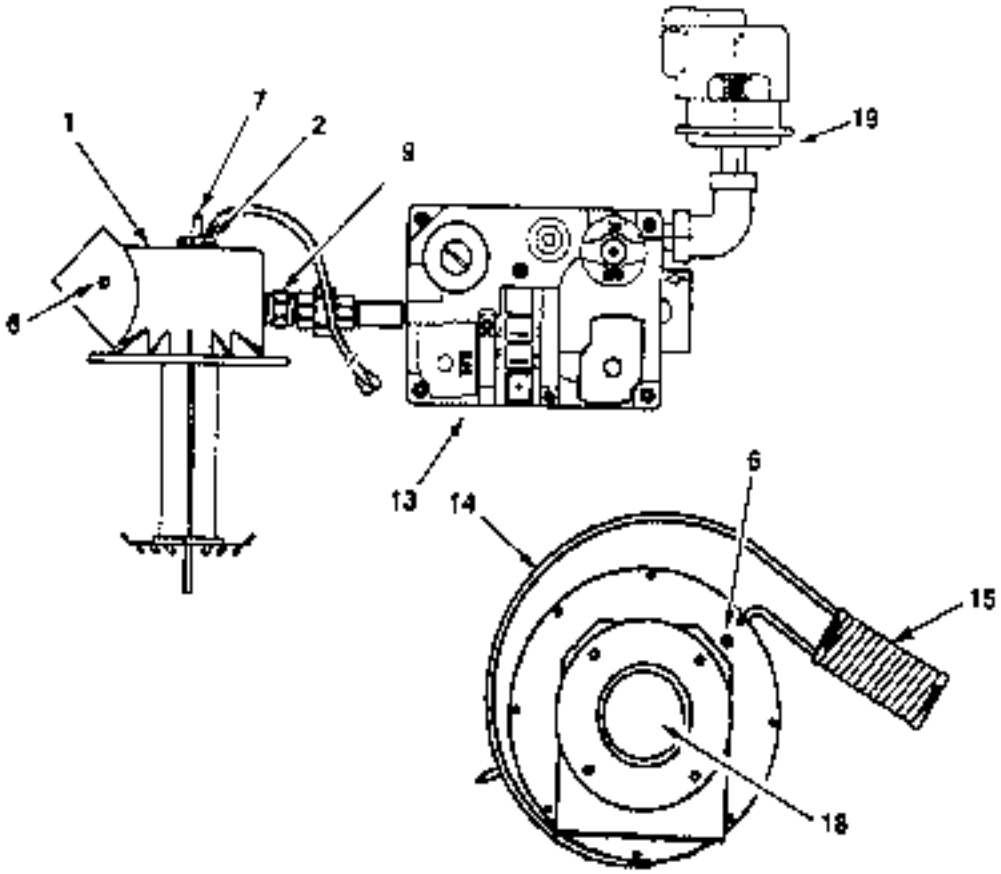
CYCLONE XHE® MODEL
BTH-120 CONTROLS PARTS LIST - SERIES 966



ITEM	DESCRIPTION	BTH-120
1	Transformer	192608-001
2	Control Board	193822-000
3	E.C.O./Temperture Probe	192606-000
4	Blower Proving Air Switch	193295-000
7	Blower Assembly	193341-000
8	Igniter Assembly	192638-000
9	Cable to Control Display Board	192623-000
10	Board, Display Panel.	192622-001
11	Blocked Outlet Proving Switch.	193294-000
12	Temperature Probe, Lower .	192609-000
14	Tubing, Pressure	192024-002
15	Tubing, Pressure	192024-006
16	Tubing, Connector	192152-000
17	Switch-On/Off	193243-000
18	Low Gas Pressure Switch	191149-001
19	Blocked Inlet Switch.	193293-000

Part numbers underlined are recommended stock items for emergency replacement.

CYCLONE XHE® MODEL
BTH-120 BURNER & BLOWER PARTS LIST - SERIES 966



ITEM	DESCRIPTION	BTH-120
1	Burner	194114-003
2	Igniter Assembly	192638-000
6	Barb, Hose, 3/16"	181863-000
7	Flame Rod Assembly	192478-000
9	Orifice	192477-003
13	Valve, Gas	192966-000
14	Blower	193341-000
15	Tube, Air	192469-010
18	Flange Assembly, Inlet	192886-001
19	Low Gas Pressure Switch.	191149-001

Parts numbers underlined are recommended stock items for emergency replacement.

A.O. SMITH

WATER PRODUCTS COMPANY

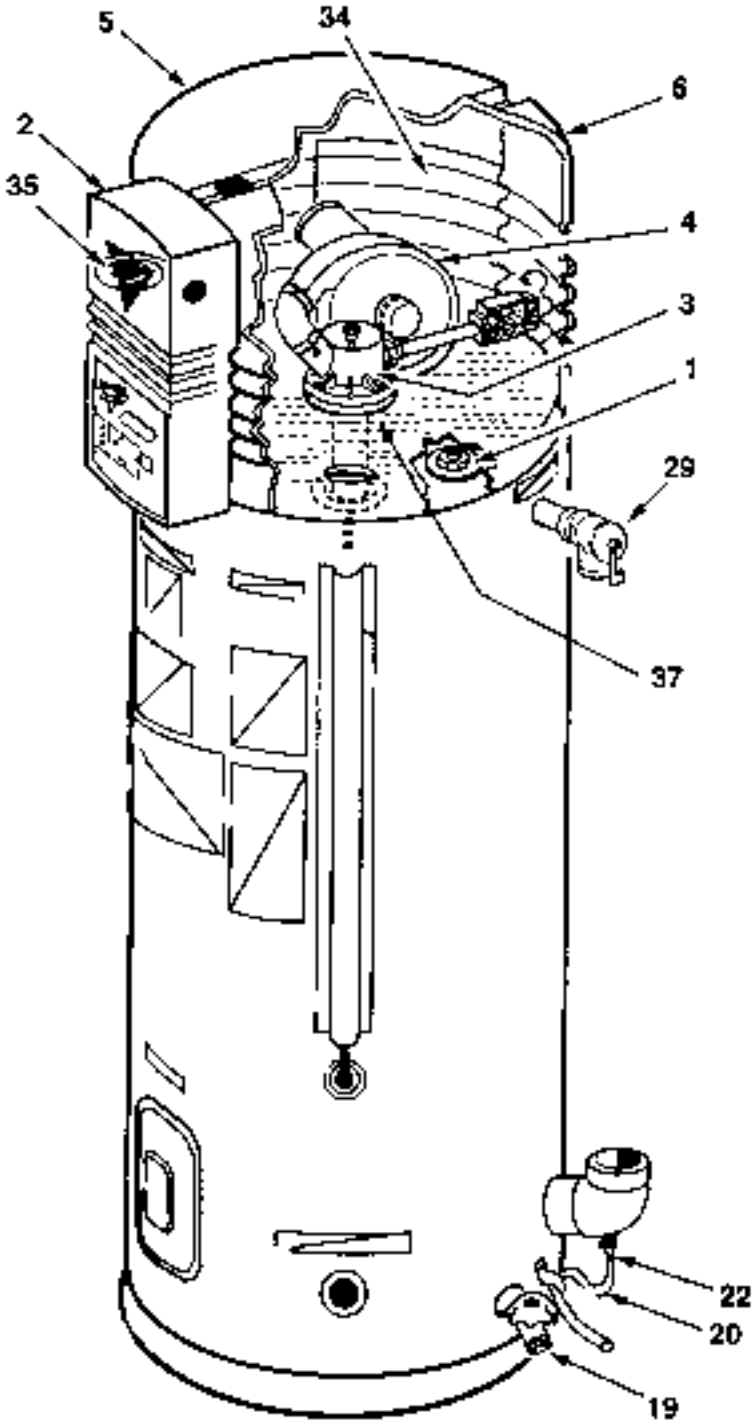
GAS

COMMERCIAL WATER HEATER PARTS LIST

CYCLONE XHE® MODEL BTH-150, BTH-199

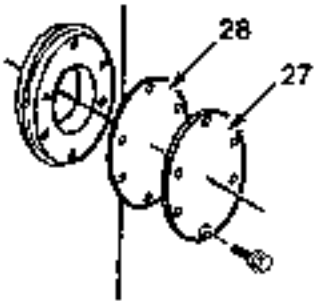
SERIES 966 & 967

(PARTIAL PARTS LISTING)



EXHAUST TERMINAL

DIRECT VENT INTAKE TEE



CLEAN OUT ASSEMBLY

A.O. SMITH WATER PRODUCTS CO., INC.

PARTS INFORMATION

PHONE: 1-800-433-2545

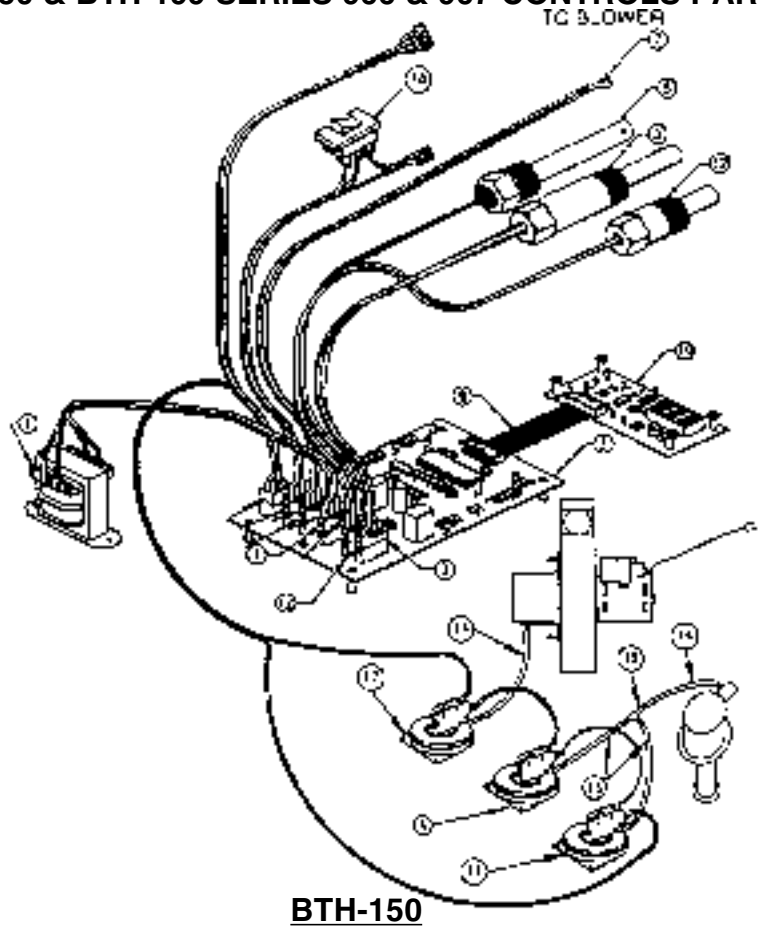
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODELS
BTH-150& BTH-199 SERIES 966 & 967 CONTROLS PARTS LIST (PARTIAL)

		BTH-150		BTH-199	
ITEM	DESCRIPTION	NATURAL	PROPANE	NATURAL	PROPANE
1	Anode	043817-053	043817-053	043817-053	043817-053
2	Panel, Front	192935-000	192935-000	192935-000	192935-000
3	Burner Assembly	194114-001	194114-005	194114-000	194114-004
4	Blower	193354-000	193354-000	193354-000	193354-000
5	Panel, Left Side	193237-000	193237-000	193237-000	193237-000
6	Panel, Right Side	193238-000	193238-000	193238-000	193238-000
19	Valve, Drain	026273-004	026273-004	026273-004	026273-004
20	Condensate Hose	191746-072	181894-072	191746-072	181894-072
22	Barb, Hose	181863-000	181863-000	181863-000	181863-000
24	Exhaust Terminal	192815-000	192815-000	192815-000	192815-000
25	Direct Vent Kit	193202-000	193202-000	193202-000	193202-000
27	Plate, Pressure	099037-000	099037-000	099037-000	099037-000
28	Gasket	099038-000	099038-000	099038-000	099038-000
29	Valve, Relief	192467-000	192467-000	192467-000	192467-000
33*	Screen, Exhaust	181662-000	181662-000	181662-000	181662-000
34	Panel, Back	193239-000	193239-000	193239-000	193239-000
37	Gasket	192331-000	192331-000	192331-000	192331-000

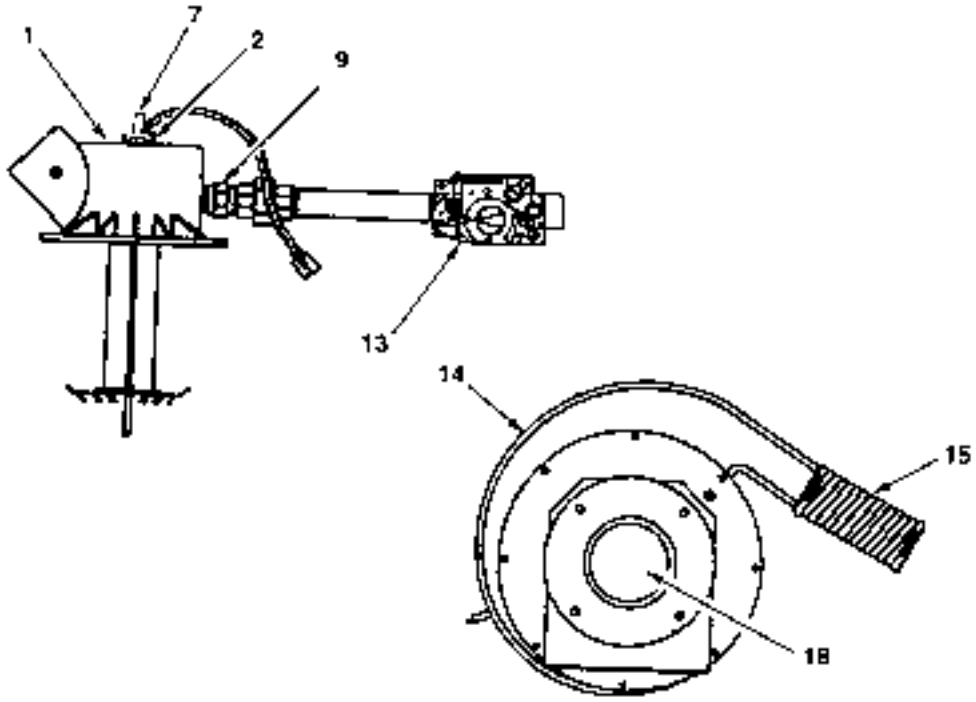
*** Not Illustrated**

CYCLONE XHE® MODELS
BTH-150 & BTH-199 SERIES 966 & 967 CONTROLS PARTS LIST



ITEM	DESCRIPTION	BTH-150 NATURAL	BTH-150 PROPANE	BTH-199 NATURAL	BTH-199 PROPANE
1	Transformer	192608-001	192608-001	192608-001	192608-001
2	Control Board	193822-000	193822-000	193822-000	193822-000
3	E.C.O./Upper Probe	192606-000	192606-000	192606-000	192606-000
4	Blower Proving Switch	193295-000	193295-000	193295-000	193295.000
7	Blower Assembly	192880-000	192880-000	192880-000	192880-000
8	Igniter Assembly	192638-000	192638-000	192638-000	192638-000
9	Cable to Control Display Board	192623-001	192623-000	192623-000	192623-000
10	Board, Display Panel	192622-001	192622-001	192622-001	192622-001
11	Blocked Outlet Switch	193362.000	193357-000	193364-000	193357-000
12	Temperature Probe, Lower	192609-000	192609-000	192609-000	192609-000
14	Tubing, Pressure	192024-006	192024-006	192024-006	192024-006
15	Tubing, Pressure	192024-004	192024-004	192024-004	192024-004
16	Connector, Tube	192152-000	192152-000	192152-000	192152-000
17	Blocked Inlet Switch	193355-000	193355-000	193363-000	193356-000
18	ON/OFF Switch	193243-000	193234-000	193234-000	193234-000

CYCLONE XHE® MODELS
BTH-150 & BTH-199 SERIES 966 & 967 BURNER & BLOWER PARTS LIST



ITEM	DESCRIPTION	BTH-150 NATURAL	BTH-150 PROPANE	BTH-199 NATURAL	BTH-199 PROPANE
1	Burner	194114-001	194114-005	194114-000	194114-004
2	Igniter Assembly	192638-000	192638-000	192638-000	192638-000
7	Flame Rod Assembly	192478-000	192478-000	192478-000	192478-000
9	Orifice	192477-001	192477-005	192477-000	192477-004
13	Valve, Gas	192797-000	192454-001	192797-000	192454-001
14	Blower	193354-000	193354-000	193354-000	193354-000
15	Tube, Air	192469-010	192469-010	192469-010	192469-010
18	Flange, Inlet	192641-001	192886-001	192641-001	192886-001

A.O. SMITH

WATER PRODUCTS COMPANY

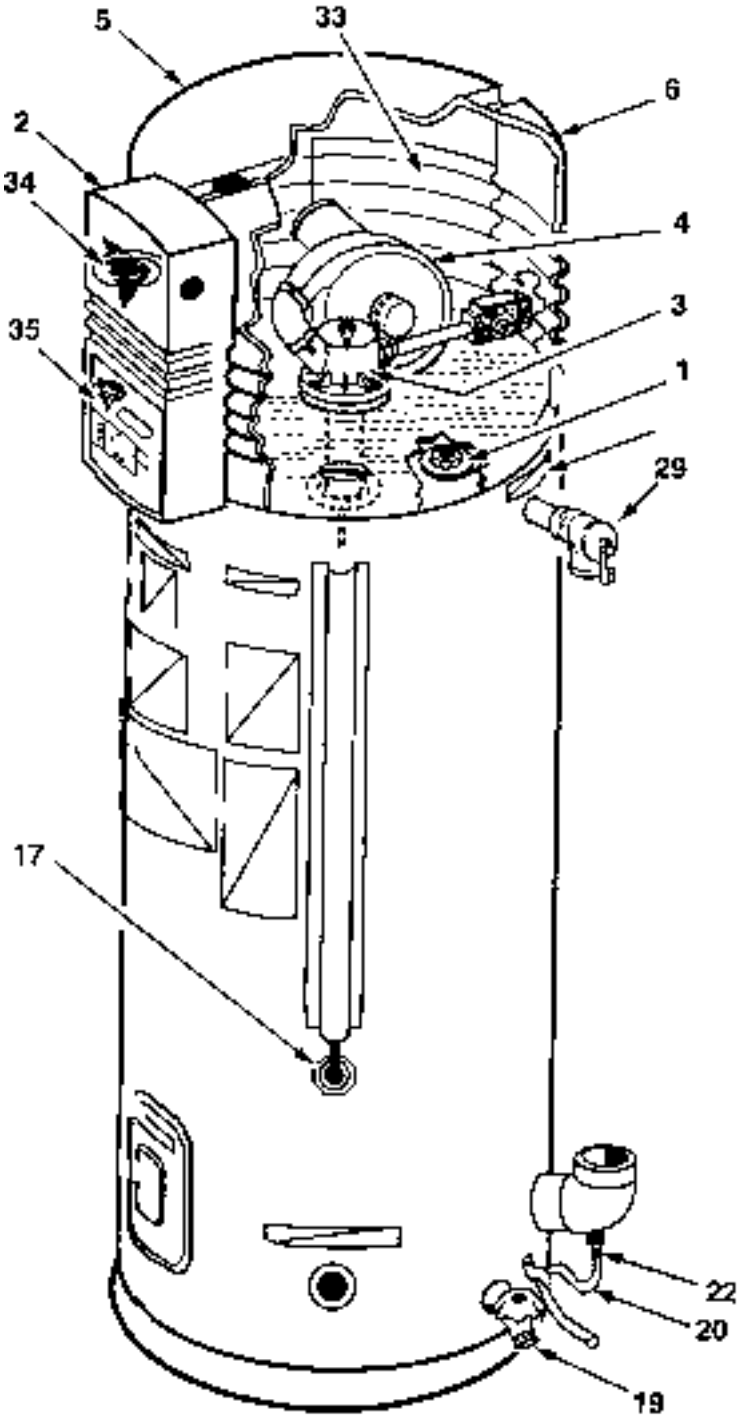
GAS

COMMERCIAL WATER HEATER PARTS LIST

CYCLONE XHE® MODEL BTH-250

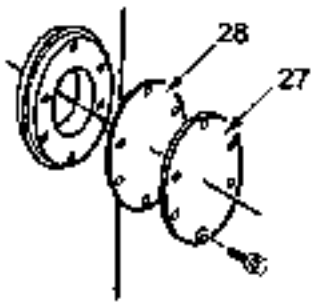
SERIES 966

(PARTIAL PARTS LISTING)



EXHAUST TERMINAL

DIRECT VENT INTAKE TEE



CLEAN OUT ASSEMBLY

A.O. SMITH WATER PRODUCTS CO., INC.

PARTS INFORMATION

PHONE: 1-800-433-2545

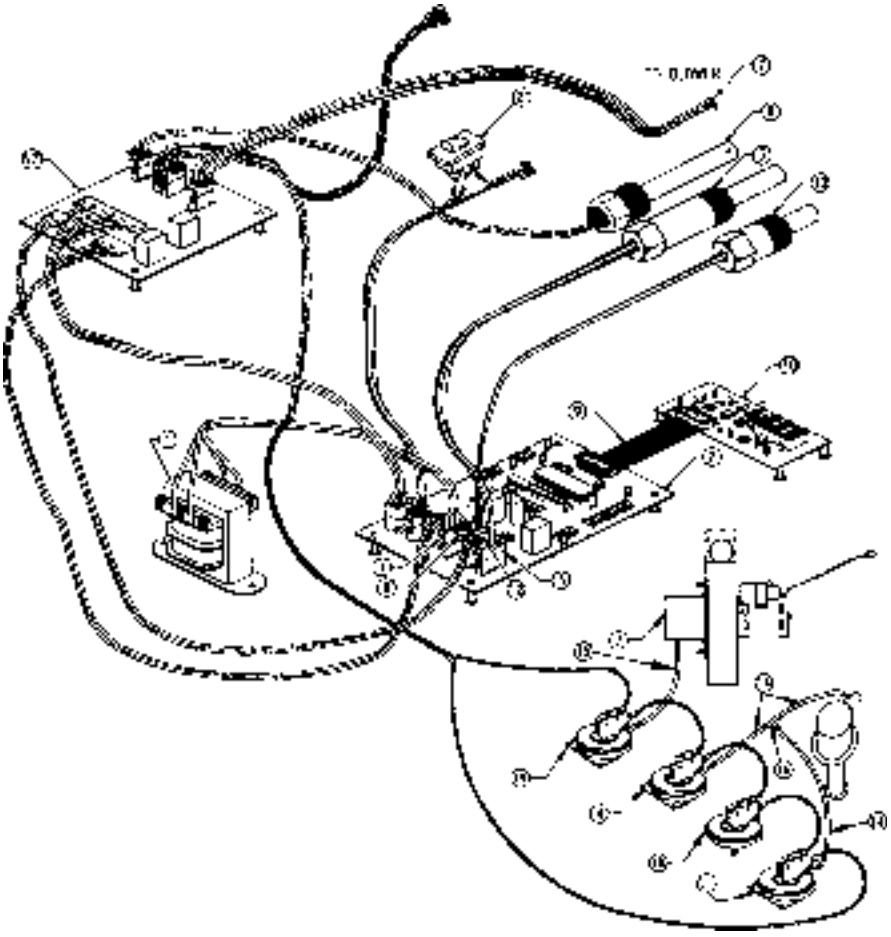
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODEL
BTH-250 WATER HEATER PARTS LIST (PARTIAL)
SERIES 966

ITEM	DESCRIPTION	BTH-250
1	Anode	043817-053
2	Panel, Front	192935-000
3	Burner Assembly	194114-002
4	Blower	193203-000
5	Panel, Left Side	193237-000
6	Panel, Right Side	193238-000
17	Temperature Probe, Lower	192609-000
19	Valve, Drain	026273-004
20	Condensate Hose	181894-072
22	Barb, Hose	181863-000
24	Exhaust Terminal	192815-000
25	Direct Vent Intake Terminal	181762-000
27	Plate, Pressure	099037-000
28	Gasket	099038-000
29	Valve, Relief	192467-000
33	Panel, Back	193239-001

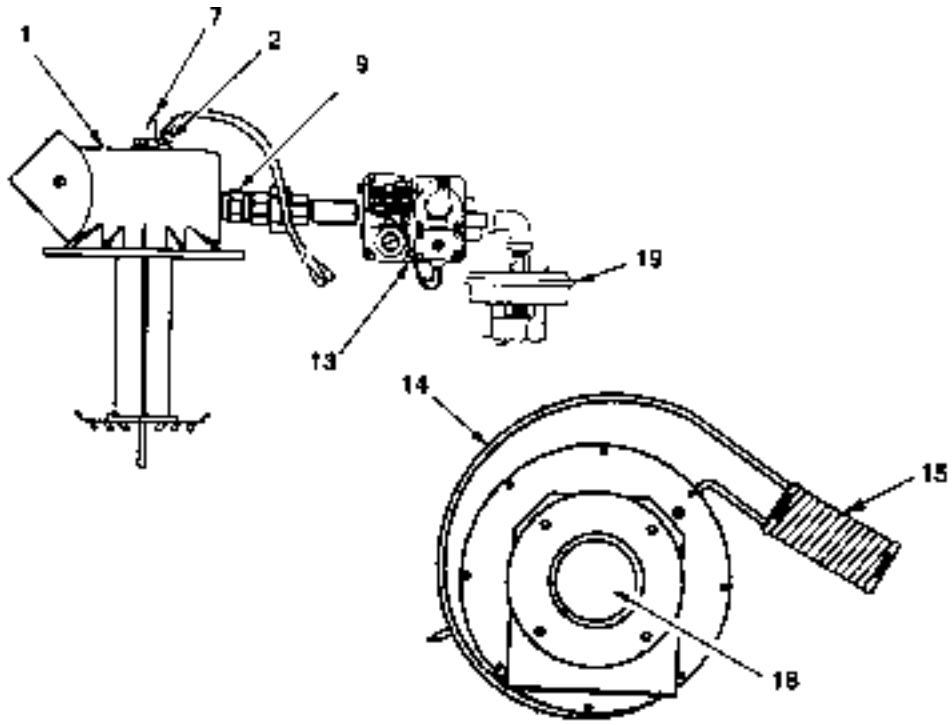
Part numbers underlined are recommended stock items for emergency replacement.

CYCLONE XHE® MODELS
BTH-250 CONTROLS PARTS LIST - SERIES 966



ITEM	DESCRIPTION	BTH-250
1	Transformer	192608-001
2	Control Board	193822-000
3	E.C.O./Temperture Probe	192606-000
4	Blower Proving Air Switch	193295-000
7	Blower Assembly	193203-000
8	Igniter Assembly	192638-000
9	Cable to Control Display Board	192623-000
10	Board, Display Panel.	192622-001
11	Blocked Outlet Proving Switch.	193357-000
12	Temperature Probe, Lower .	192609-000
14	Tubing, Pressure	192024-001
15	Tubing, Pressure	192024-006
16	Tubing, Connector	192152-000
17	Blower Speed Reducing Panel	192987-000
18	Low Gas Pressure Switch	191149-001
19	Blocked Inlet Switch.	193361-000
21	Switch-On/Off	193243-000

CYCLONE XHE® MODELS
BTH-250 BURNER & BLOWER PARTS LIST - SERIES 966



ITEM	DESCRIPTION	BTH-250
1	Burner	194114-002
2	Igniter Assembly	192638-000
7	Flame Rod Assembly	192478-000
9	Orifice	192477-002
13	Valve, Gas	192454-000
14	Blower	193203-000
15	Tube, Air	192469-010
18	Flange Assembly, Inlet	192886-001
19	Low Gas Pressure Switch.	191149-001

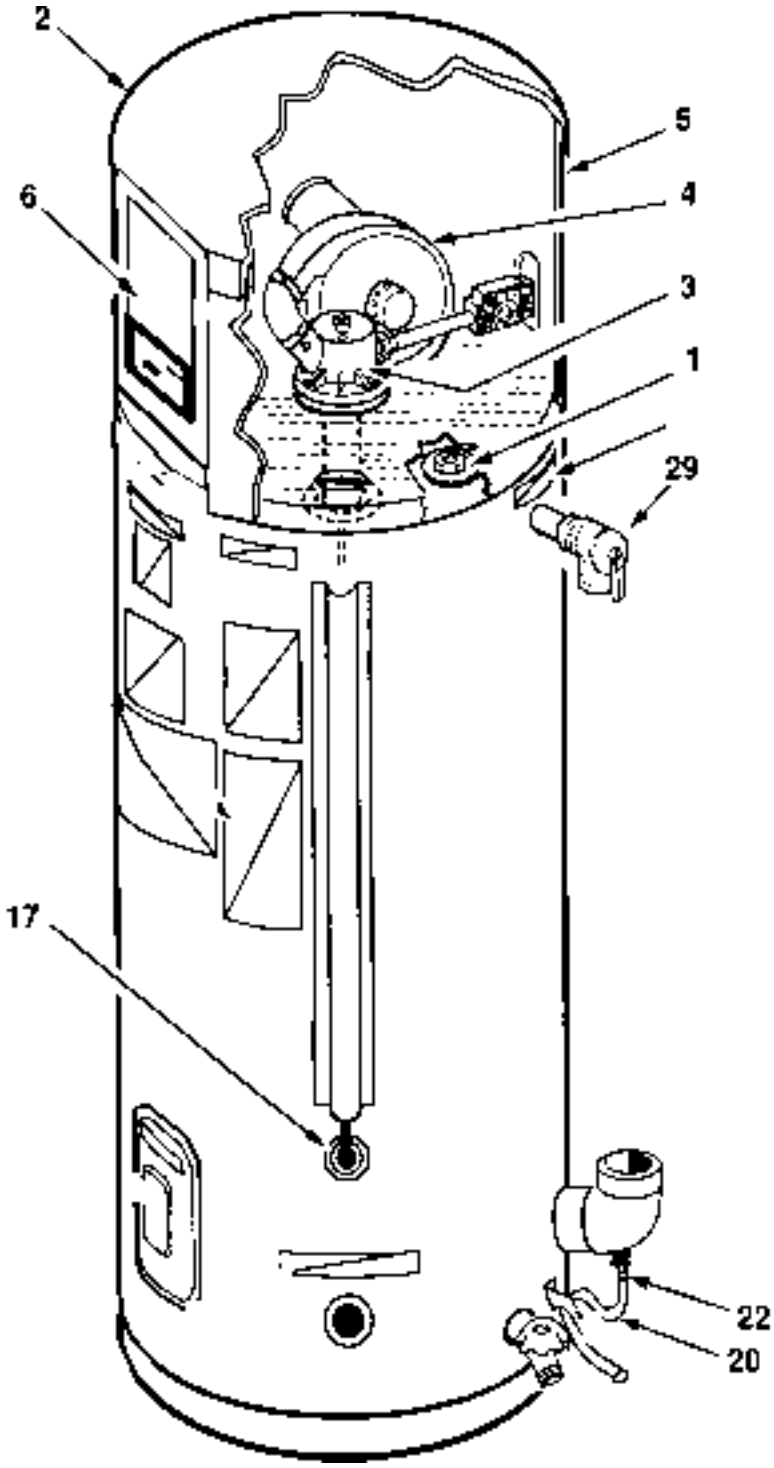
Parts numbers underlined are recommended stock items for emergency replacement.

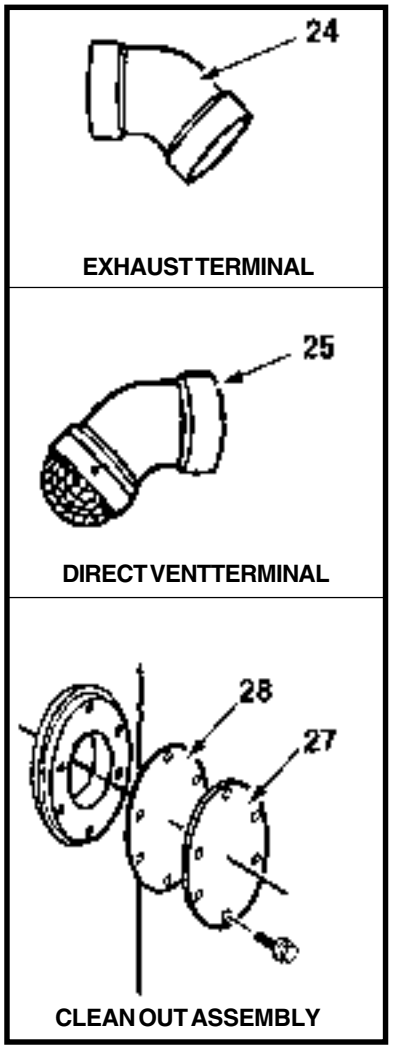
A.O. SMITH
WATER PRODUCTS COMPANY

GAS

COMMERCIAL WATER HEATER PARTS LIST

CYCLONE XHE® MODEL BTH-150, BTH-199
SERIES 960



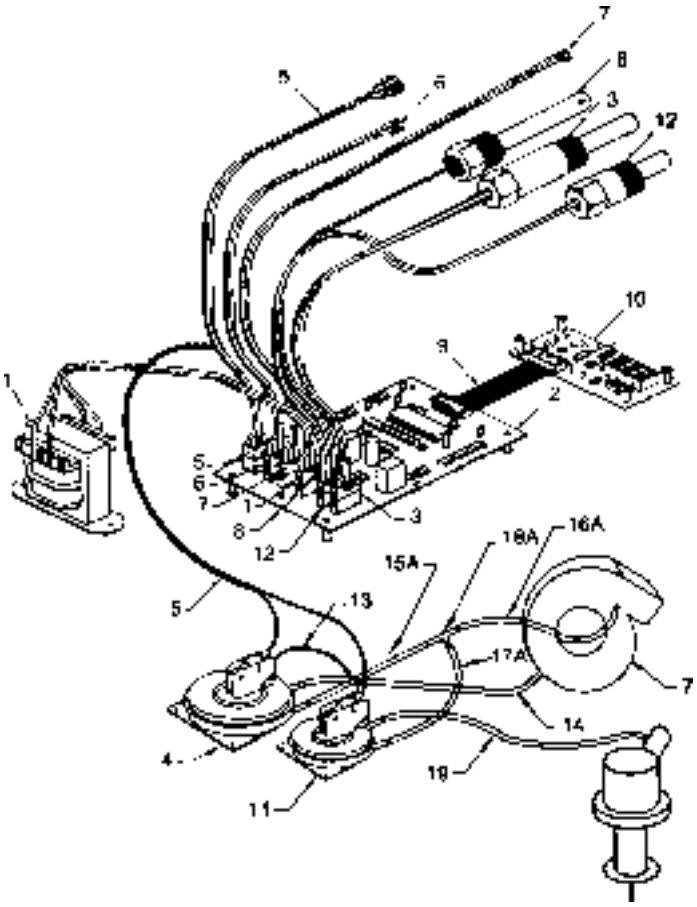


A.O. SMITH WATER PRODUCTS CO., INC.
PARTS INFORMATION
PHONE: 1-800-433-2545
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODEL
BTH-150 & BTH-199 WATER HEATER PARTS LIST
SERIES 960

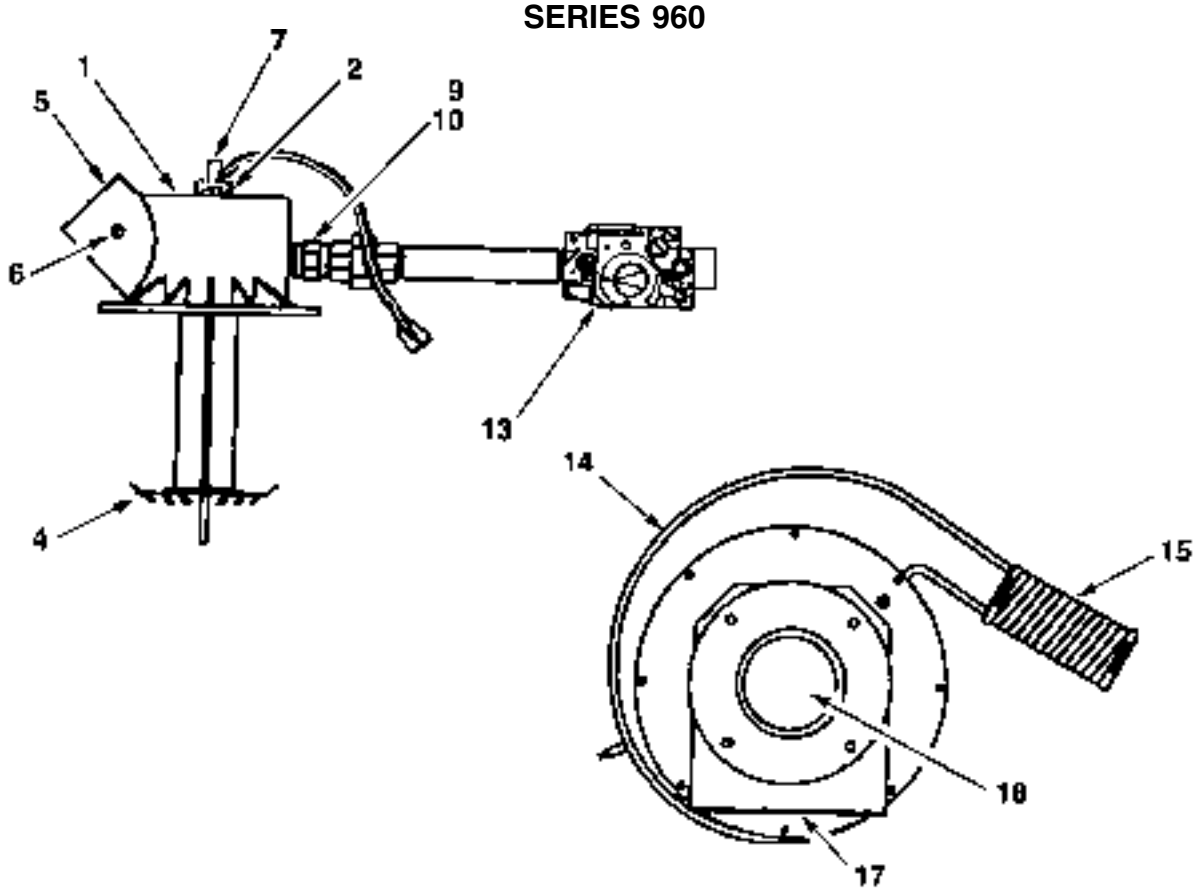
ITEM	DESCRIPTION	BTH-150	BTH-199
1	Anode	043817-053	043817-053
2	Cover, Jacket	192664-000	192664-000
3	Burner Assembly	192417-001	192417-001
4	Motor, Blower	192880-000	192880-000
5	Cage, Housing	192420-000	192420-000
6	Bracket, Control Panel	192716-000	192716-000
17	Temperature Probe, Lower	192609-000	192609-000
20	Condensate Hose	191746-072	191746-072
22	Barb, Hose	181863-000	181863-000
24	Exhaust Terminal	181901-000	181901-000
25	Direct Vent Kit	182167-000	182167-000
27	Plate, Pressure	099037-000	099037-000
28	Gasket	099038-000	099038-000
29	Valve, Relief	191617-000	191617-000

CYCLONE XHE® MODEL
BTH-150 & BTH-199 WATER HEATER PARTS LIST
SERIES 960



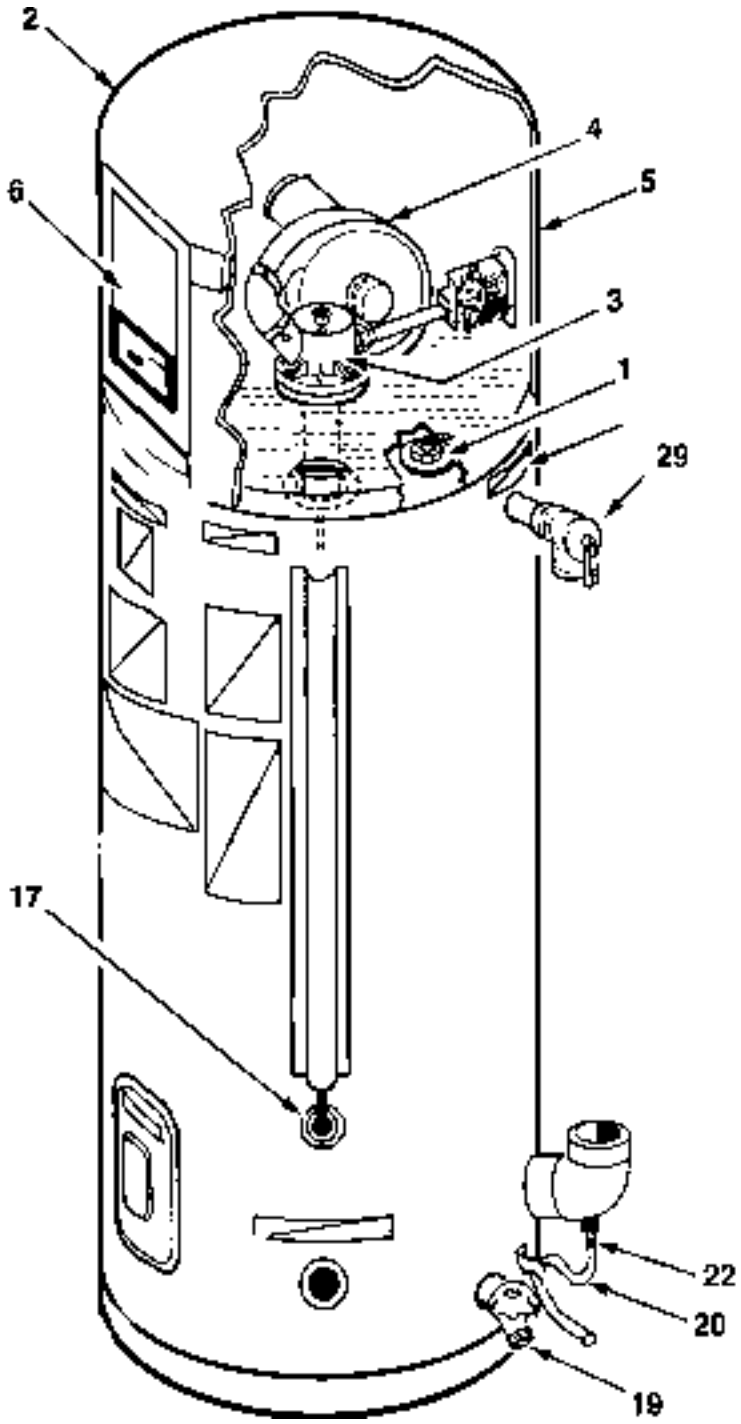
ITEM	DESCRIPTION	BTH-150	BTH-199
1	Transformer	192608-000	192608-000
2	Control Board	192624-000	192624-000
3	E.C.O./Temperture Probe	192606-000	192606-000
4	Blower Proving Air Switch	193811-000	193811-000
5	Low Voltage Cable Assembly	192605-000	192605-000
6	Line Voltage Cable Assembly	192607-000	192607-000
7	Blower Assembly	192468-000	192468-000
8	Igniter Assembly	192638-000	192638-000
9	Cable to Control Display Board	192623-000	192623-000
10	Board, Display Panel	192622-001	192622-001
11	Blocked Flue Proving Switch	192810-000	192810-000
12	Temperature Probe, Lower	192609-000	192609-000
13	Wire Assembly, Air Flow Switch	192802-000	192802-000
14	Tubing, Pressure	192024-014	192024-014
15A	Tubing, Pressure	192024-004	192024-004
16A	Tubing, Pressure	192024-004	192024-004
17A	Tubing, Pressure	192024-008	192024-008
18A	Connector, Tube	192152-000	192152-000
19	Tubing, Pressure	192024-008	192024-008

CYCLONE XHE® MODEL
BTH-150 & BTH-199 BURNER & BLOWER PARTS LIST
SERIES 960

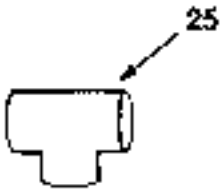


ITEM	DESCRIPTION	BTH-150	BTH-199
1	Burner	192416-000	192416-000
2	Igniter Assembly	192638-000	192638-000
4	Air Deflector	192414-000	192414-000
5	Air Restrictor	192450-001	192450-001
6	Barb, Hose, 3/16"	192800-000	192800-000
7	Flame Rod Assembly	192478-000	192478-000
9	Orifice	192477-001	192477-000
10	Orifice Holder.	192447-000	192447-000
13	Valve, Gas	192797-000	192797-000
14	Blower	192468-000	192468-000
15	Tube, Air	192469-000	192469-000
17	Bracket, Blower Mounting	192482-000	192482-000
18	Flange Inlet	192641-000	192641-000

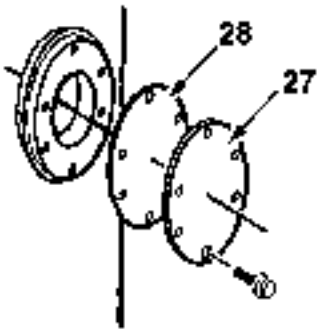
COMMERCIAL WATER HEATER PARTS LIST
CYCLONE XHE® MODEL BTH-250
SERIES 962
(PARTIAL PARTS LISTING)



EXHAUST TERMINAL



DIRECT VENT INTAKE TEE



CLEAN OUT ASSEMBLY

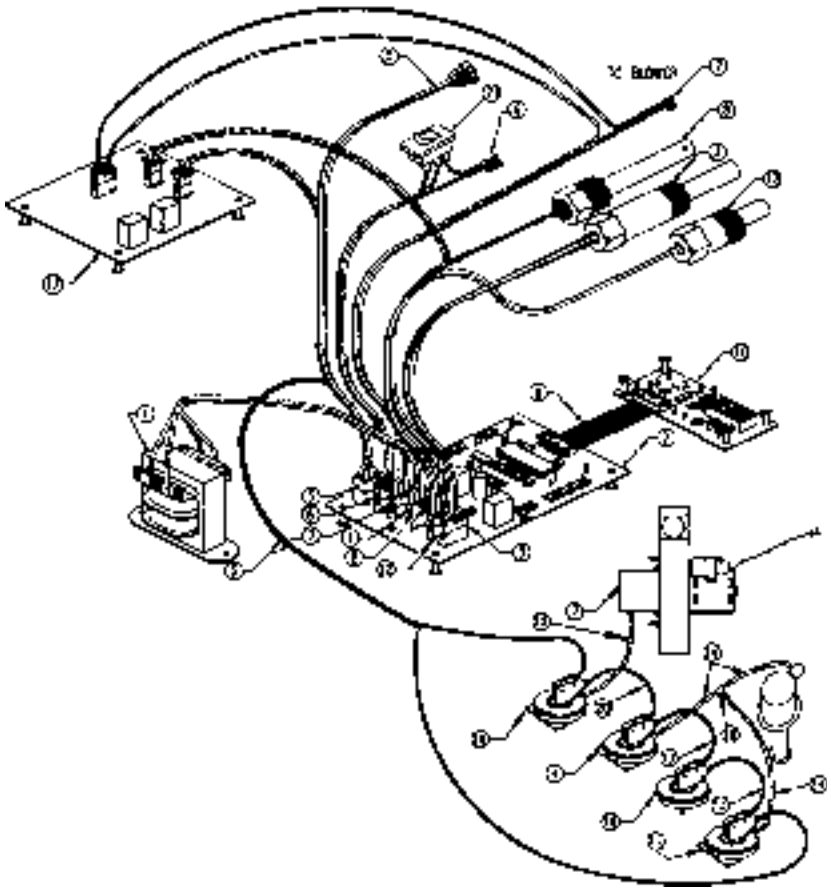
A.O. SMITH WATER PRODUCTS CO., INC.
PARTS INFORMATION
PHONE: 1-800-433-2545
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODEL
BTH-250 WATER HEATER PARTS LIST (PARTIAL)
SERIES 962

ITEM	DESCRIPTION	BTH-250
1	Anode	043817-004
2	Cover, Jacket	192664-000
3	Burner Assembly	192417-003
4	Motor, Blower	193203-000
5	Cage, Housing	192420-000
6	Bracket, Control Panel	192716-000
17	Temperature Probe, Lower	192609-000
20	Condensate Hose	181864-000
22	Barb, Hose	181863-000
24	Exhaust Vent Terminal	192815-000
25	Direct Vent Intake Tee	181762-000
27	Plate, Pressure	099037-000
28	Gasket	099038-000
29	Valve, Relief	192467-000

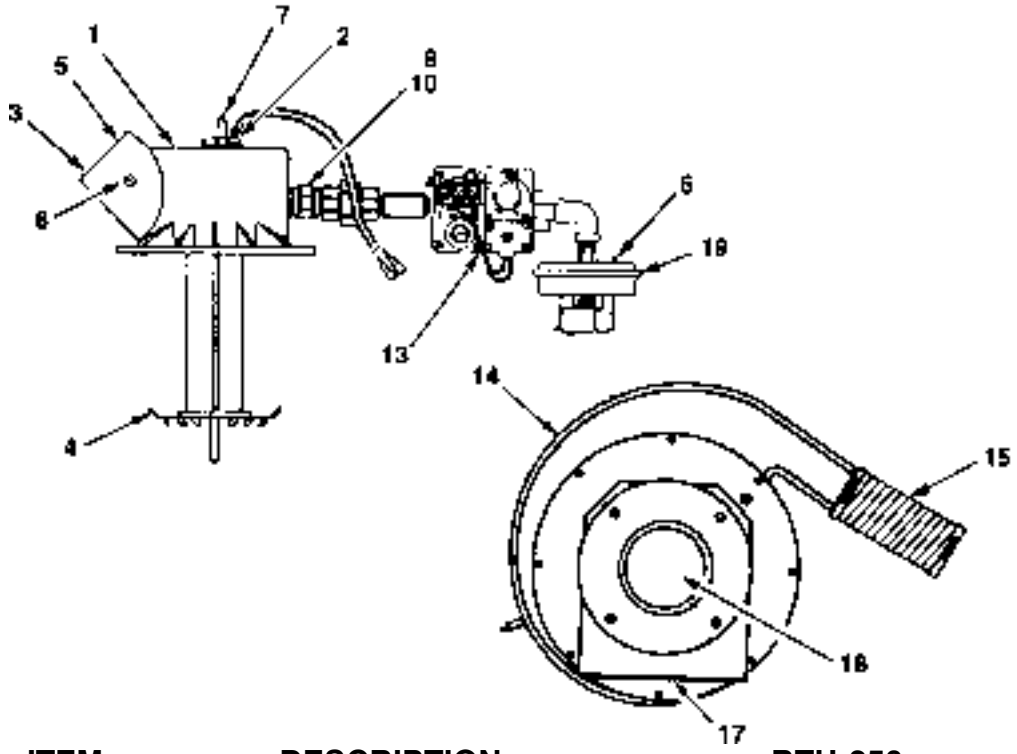
Part numbers underlined are recommended stock items for emergency replacement.

CYCLONE XHE® MODELS
BTH-250 CONTROLS PARTS LIST - SERIES 962



ITEM	DESCRIPTION	BTH-250
1	Transformer	192608-001
2	Control Board	192624-000
3	E.C.O./Temperture Probe	192606-000
4	Blower Proving Air Switch	193221-000
5	Low Voltage Cable Assembly	192605-000
6	Line Voltage Cable Assembly	192607-000
7	Blower Assembly	193203-000
8	Igniter Assembly	192638-001
9	Cable to Control Display Board	192623-000
10	Board, Display Panel.	192622-000
11	Blocked Outlet Proving Switch.	192946-000
12	Temperature Probe, Lower .	192609-000
13	Wire Assembly, Air Flow Switch	192802-001
14	Tubing, Pressure	192024-002
15	Tubing, Pressure	192024-006
16	Tubing, Connector	192152-000
17	Blower Speed Reducing Panel	192987-000
18	Low Gas Pressure Switch	191149-001
19	Blocked Inlet Switch.	192947-000
20	Wire Assembly, Air Flow Switch	192802-000
21	Switch-On/Off	192699-000

CYCLONE XHE® MODELS
BTH-250 BURNER & BLOWER PARTS LIST - SERIES 962

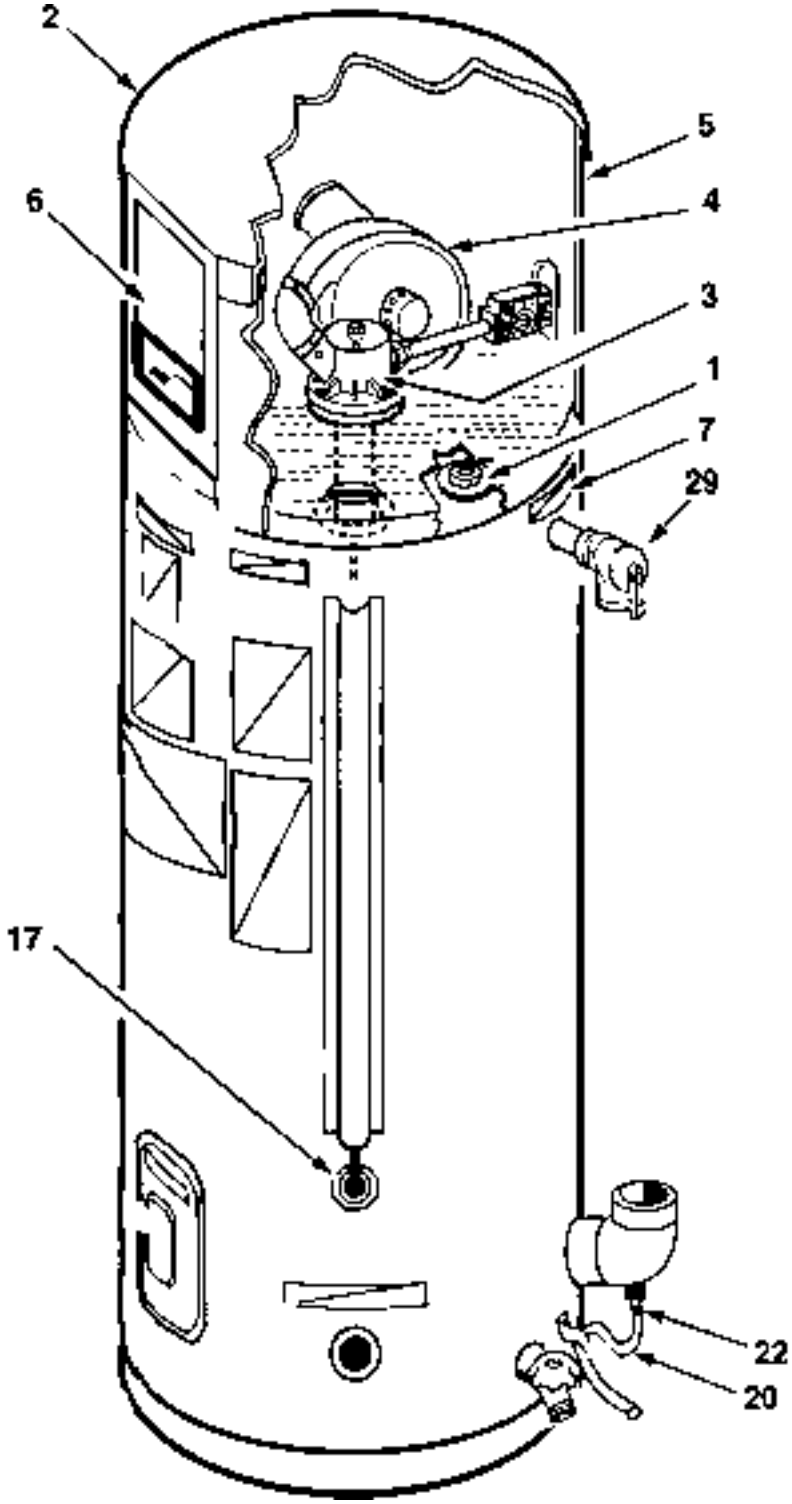


ITEM	DESCRIPTION	BTH-250
1	Burner	192416-000
2	Igniter Assembly	192638-000
3	Rivet, Blind, 1/8" Dia 316 SS	192730-000
4	Air Deflector	192414-000
5	Air Restrictor	192450-002
6	Barb, Hose, 3/16"	192800-000
7	Flame Rod Assembly	192478-000
9	Orifice	192477-002
10	Orifice Holder.	192447-000
13	Valve, Gas	192454-000
14	Blower	193203-000
15	Tube, Air	192469-010
17	Bracket, Blower Mounting	192482-000
18	Flange Assembly, Inlet	192886-000
19	Low Gas Presure Switch.	191149-001

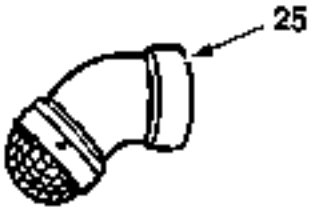
Parts numbers underlined are recommended stock items for emergency replacement.

COMMERCIAL WATER HEATER PARTS LIST

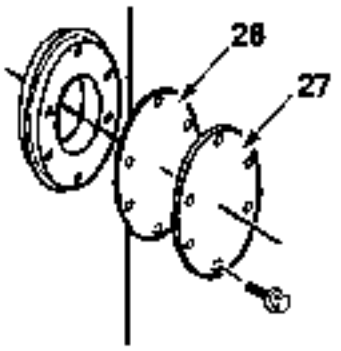
CYCLONE XHE® MODEL BTH-150 & BTH-199
SERIES 962
(PARTIAL PARTS LISTING)



EXHAUST TERMINAL



DIRECT VENT TERMINAL



CLEAN OUT ASSEMBLY

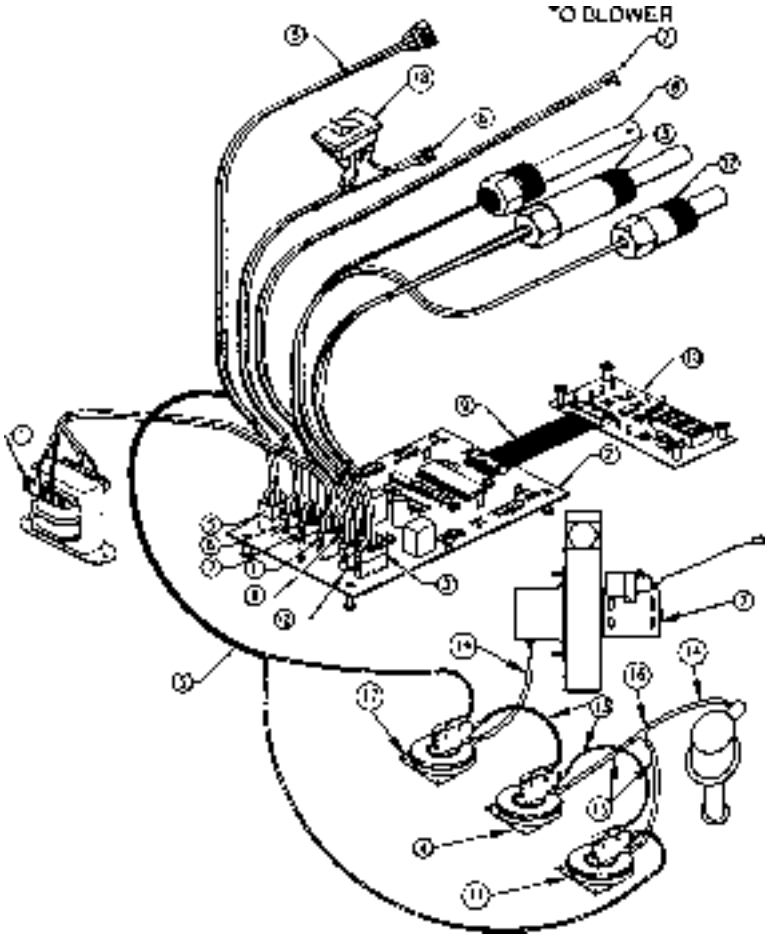
A.O. SMITH WATER PRODUCTS CO., INC.
PARTS INFORMATION
PHONE: 1-800-433-2545
FAX: 1-800-433-2515 • WWW.HOTWATER.COM

CYCLONE XHE® MODEL
BTH-150 & BTH-199 WATER HEATER PARTS LIST - SERIES 962

ITEM	DESCRIPTION	BTH-150	BTH-199
1	Anode	043817-053	043817-053
2	Cover, Jacket	192664-000	192664-000
3	Burner Assembly	192417-001	192417-001
4	Motor, Blower	192880-000	192880-000
5	Cage, Housing	192420-000	192420-000
6	Bracket, Control Panel	192716-000	192716-000
17	Temperature Probe, Lower	192609-000	192609-000
20	Condensate Hose	191746-072	191746-072
22	Barb, Hose	181863-000	181863-000
24	Exhaust Terminal	181901-000	181901-000
25	Direct Vent Kit	182167-000	182167-000
27	Plate, Pressure	099037-000	099037-000
28	Gasket	099038-000	099038-000
29	Valve, Relief	191617-000	191617-000

Part numbers underlined are recommended stock items for emergency replacement.

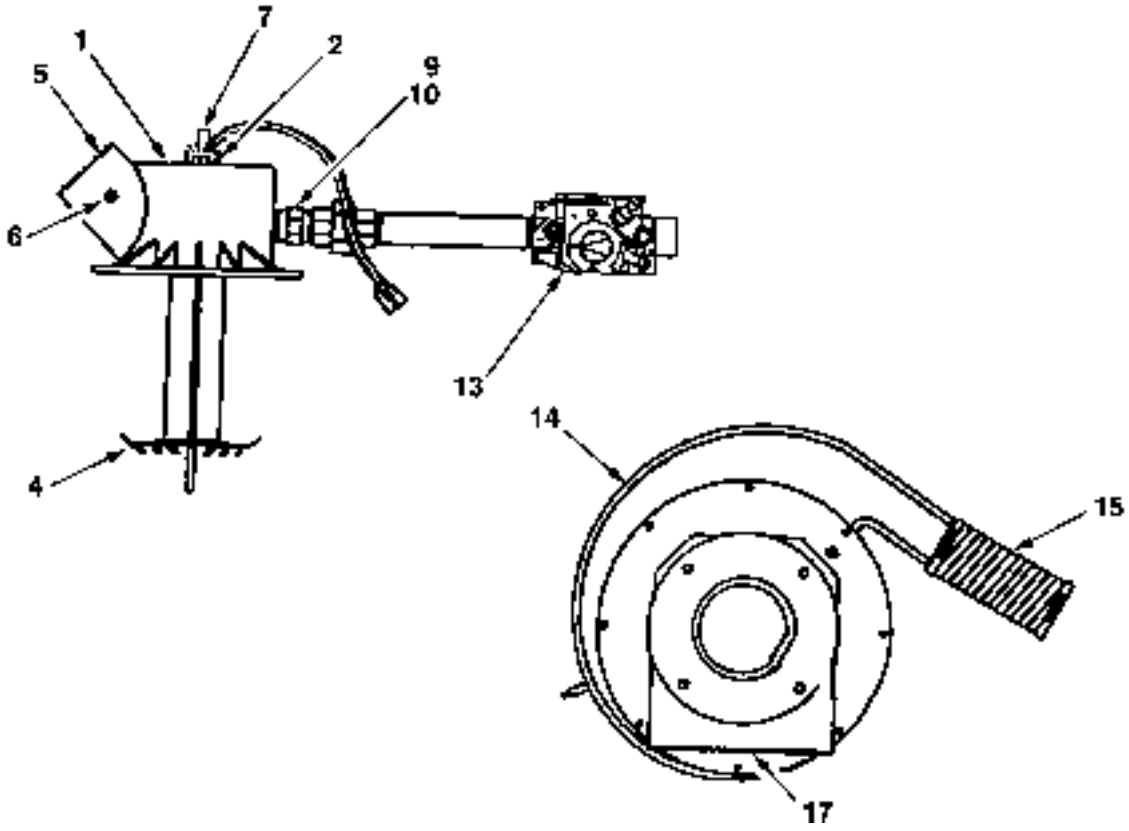
CYCLONE XHE® MODELS
BTH-150 & BTH-199 CONTROLS PARTS LIST - SERIES 962



ITEM	DESCRIPTION	BTH-150	BTH-199
1	Transformer	192608-000	192608-000
2	Control Board	192624-000	192624-000
3	E.C.O./Temperture Probe	192606-000	192606-000
4	Blower Proving Air Switch	193221-000	193221-000
5	Low Voltage Cable Assembly	192605-000	192605-000
6	Line Voltage Cable Assembly	192607-000	192607-000
7	Blower Assembly	192468-000	192468-000
8	Igniter Assembly	192638-000	192638-000
9	Cable to Control Display Board	192623-000	192623-000
10	Board, Display Panel.	192622-000	192622-000
11	Blocked Flue Proving Switch.	192878-000	192878-000
12	Temperature Probe, Lower .	192609-000	192609-000
13	Wire Assembly, Air Flow Switch	192802-000	192802-000
14	Tubing, Pressure	192024-014	192024-014
15	Tubing, Pressure	192024-004	192024-004
16	Connector, Tube	192152-000	192152-000
17	Blocked Inlet Proving Switch.	192882-000	192882-000
18	Switch-On/Off	192699-000	192699-000

Parts numbers underlined are recommended stock items for emergency replacement.

CYCLONE XHE® MODELS
BTH-150 & BTH-199 BURNER & BLOWER PARTS LIST
SERIES 962



ITEM	DESCRIPTION	BTH-150	BTH-199
1	Burner	192416-000	192416-000
2	Igniter Assembly	192638-000	192638-000
4	Air Deflector	192414-000	192414-000
5	Air Restrictor	192450-001	192450-001
6	Barb, Hose, 3/16"	192800-000	192800-000
7	Flame Rod Assembly	192478-000	192478-000
9	Orifice	192477-001	192477-001
10	Orifice Holder.	192447-000	192447-000
13	Valve, Gas (Honeywell)	192797-000	192797-000
14	Blower	192468-000	192468-000
15	Tube, Air	192469-010	192469-010
17	Bracket, Blower Mounting	192482-000	192482-000

Parts numbers underlined are recommended stock items for emergency replacement.

Notes

Notes